FINAL REPORT
FOR THE
CLARK FORK RIVER DEMONSTRATION PROJECT WARM SPRINGS, MONTANA

SUBMITTED TO:
OFFICE OF THE GOVERNOR
CAPITOL STATION
HELENA, MONTANA 59620

SUBMITTED BY:
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Date:
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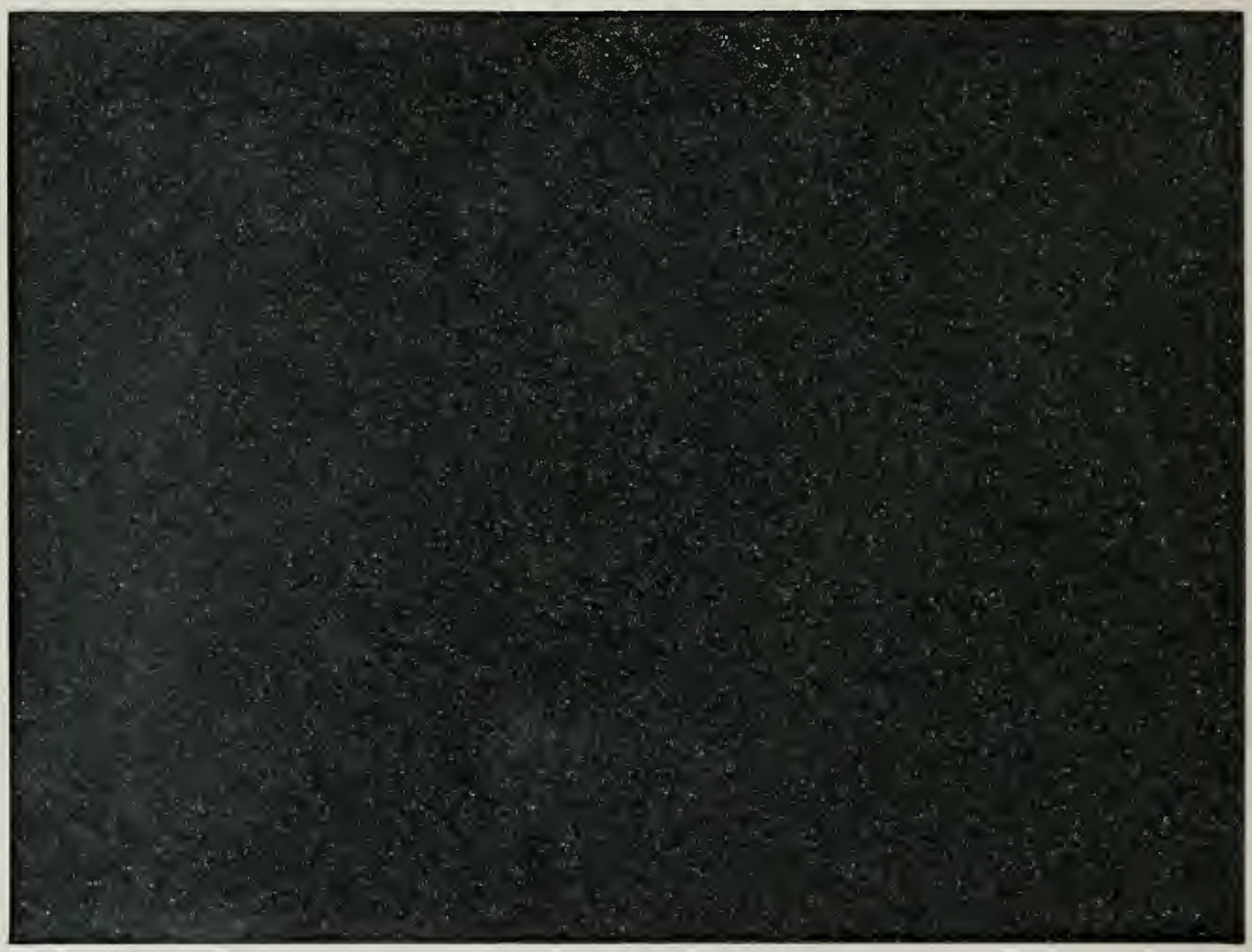

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PROFESSIONAL CERTIFICATION

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Project No. 57

This report has been prepared by Schafer and Associates under the professional supervision of the undersigned.

The data, analysis, and conclusions are presented, within the limits prescribed by the client, after being prepared in accordance with generally accepted professional engineering and scientific practice. There is no other warranty, either express or implied.

Bruce K Parker

Bruce K. Parker
Project Manager

William M Schafer

William Schafer
Principal

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1.0 EXECUTIVE SUMMARY

A project aimed at demonstrating in-place reclamation methods for toxic mine tailings, and fisheries rehabilitation, was completed on the upper Clark Fork River, near Warm Springs, Montana. The demonstration project was funded by a $1,000,000 contribution from ARCO Coal, to the State of Montana, of which $750,000 was allocated to this demonstration project. An advisory council comprised of individuals from State and Federal regulatory agencies, private industry, and special interest groups was appointed to oversee the timely completion of the study.

General tasks accomplished during the project were:

- selection of an appropriate area to perform the clean-up;
- development of an acceptable, effective clean-up plan;
- site characterization, landowner agreements and permitting;
- preliminary design and approval, with public input;
- final project design, bid package and contractor selection;
- project construction and supervision;
- final project report including management/monitoring plans.

The goal of the demonstration study was to demonstrate the effectiveness of in-place reclamation methods in stabilizing and/or neutralizing streamside tailings, and to improve or maintain water quality and fisheries habitat on the upper Clark Fork River. Further, the selected reclamation methods must be applicable to other tailings contaminated portions of the river.

The design approach used by the project team to meet the goal(s) of the demonstration project involved the removal of tailings from actively eroding streambank areas and placing those tailings in more stable geomorphic locations away from the river, stabilization of those same streambanks, addition and incorporation of chemical amendments (lime) to neutralize the tailings, improved surface water quality and sediment control, revegetation with grasses and willows, and land use management planning.

This approach was based on many years of field and laboratory research projects within the upper Clark Fork basin and elsewhere on similar mining waste sites. The potential success of these methods is not "theoretical" but is built on numerous trial and error experiences involving reclamation of mining waste sites and alluvial systems. Advantages of *in-situ* chemical treatment and revegetation include reduction in surface water and air pollution through erosion, improvement in land productivity and value, probable reduction in potential food chain accumulation of metals, and reduced leachate of metals

to ground water. Another key advantage of this treatment is that contaminated soils can be treated to a depth of four feet or more. For this project area, nearly all tailings were economically treated. This "volumetric" treatment insures that if tailings are later eroded into the river due to migration of the channel, the tailings will be neutral and hence less damaging to aquatic organisms and fish.

Specifically, the completed project encompassed approximately 1.5 miles of the Clark Fork River, from the Warm Springs Bridge north to the Perkins Lane Bridge. Actual construction items are summarized below:

- Restoration and stabilization of approximately 3200 lineal feet of streambank;
- Modification of the stream channel (11 locations) to reduce the effects of scour on unstable streambanks;
- Addition and incorporation of 923 tons of calcium oxide and 5671 tons of calcium carbonate;
- Deep tillage of 56 acres of tailings greater than 12 inches in depth, and agricultural tillage of 22 acres of tailings less than 12 inches in depth;
- Reseeding of 85 acres with seed mixtures selected in conference with SCS and landowners, including fertilize and mulch;
- Construction of 24 small, 23 medium and 8 large erosion/sediment control structures at selected points where surface runoff or bank overflow re-enter the river;
- Construction of 6886 lineal feet of 5-wire fence to aid in grazing rotation and control;
- Development of a grazing management plan in conference with SCS and landowners;

The design and construction phase of the Clark Fork River Demonstration Project was completed in 1990. The purpose of this report is to discuss engineering design, permitting, contractor selection, construction costs, and upcoming project monitoring for the project.

2.0 INTRODUCTION

2.1 Overview

In response to a July, 1989 fish kill, ARCO Coal contributed $1,000,000 to the State of Montana for fisheries rehabilitation and a reclamation demonstration project aimed at mitigating future impacts until the CERCLA clean-up can be completed. Through Executive Order 21-89, Governor Stan Stephens allocated $750,000 for the Clark Fork Demonstration study and appointed a 6 member Clark Fork Rehabilitation Advisory Council. The purpose of the Council was to oversee development of a remedial plan, selection of a contractor for the clean-up, and completion of the scheduled clean-up by September 1, 1990.

Schafer and Associates (Schafer), in association with Spectrum Engineering (Spectrum) and Interfluve, Inc. (Interfluve), were selected as the Consultant(s) to design and administer a project to demonstrate reclamation techniques to improve the Clark Fork River fishery, water quality, and forage production. Clean-up methods were designed to protect environmental media (air, soil, surface water and groundwater) from further contamination by heavy metals while benefitting agricultural, environmental and sportsman interests alike. If the reclamation techniques used prove to be successful, the remedial methods may be applied to future EPA and ARCO clean-up actions. In addition, the reclamation techniques will focus public attention on the Clark Fork River and may accelerate clean-up efforts as well.

The purpose of this report is to describe the engineering design criteria, identify the contractor selection process, document clean-up costs, and outline a monitoring plan. Alternative monitoring plans are also proposed. For further background on the project approach, and a conceptual understanding of the site the reader is referred to the project proposal (Schafer 1989), and to subsequent technical reports.

2.2 Project Location and Description

The Clark Fork River Demonstration Project area encompasses approximately 110 acres just below the Warm Springs Ponds, and is located within the E 1/2, E 1/2 of Section 7, the W 1/2, W 1/2 of Section 8, and the NW 1/4 of Section 18, Township 5 North, Range 3 East. The upstream end of the project area begins at the Warm Springs bridge on the Warm Springs interchange road, and extends northerly approximately 1 1/2 miles to the downstream end of the project area at Perkins Lane Bridge (Figure 2.1). Ownership within the project includes ARCO, Montana Fish Wildlife and Parks, and private landowners (Figure 2.2).

The entire project area lies predominantly within the riparian zone of the Clark Fork River floodplain, below the confluence of Warm Springs Creek and Silver Bow Creek.

Vegetation consists of a mixture of deciduous trees and shrubs (willow, birch and alder) and native grasses. Numerous areas within the site are devoid of vegetation, or partially covered with dead trees, as a result of tailings pollution. A berming project sponsored by ARCO was completed in the area during 1989.

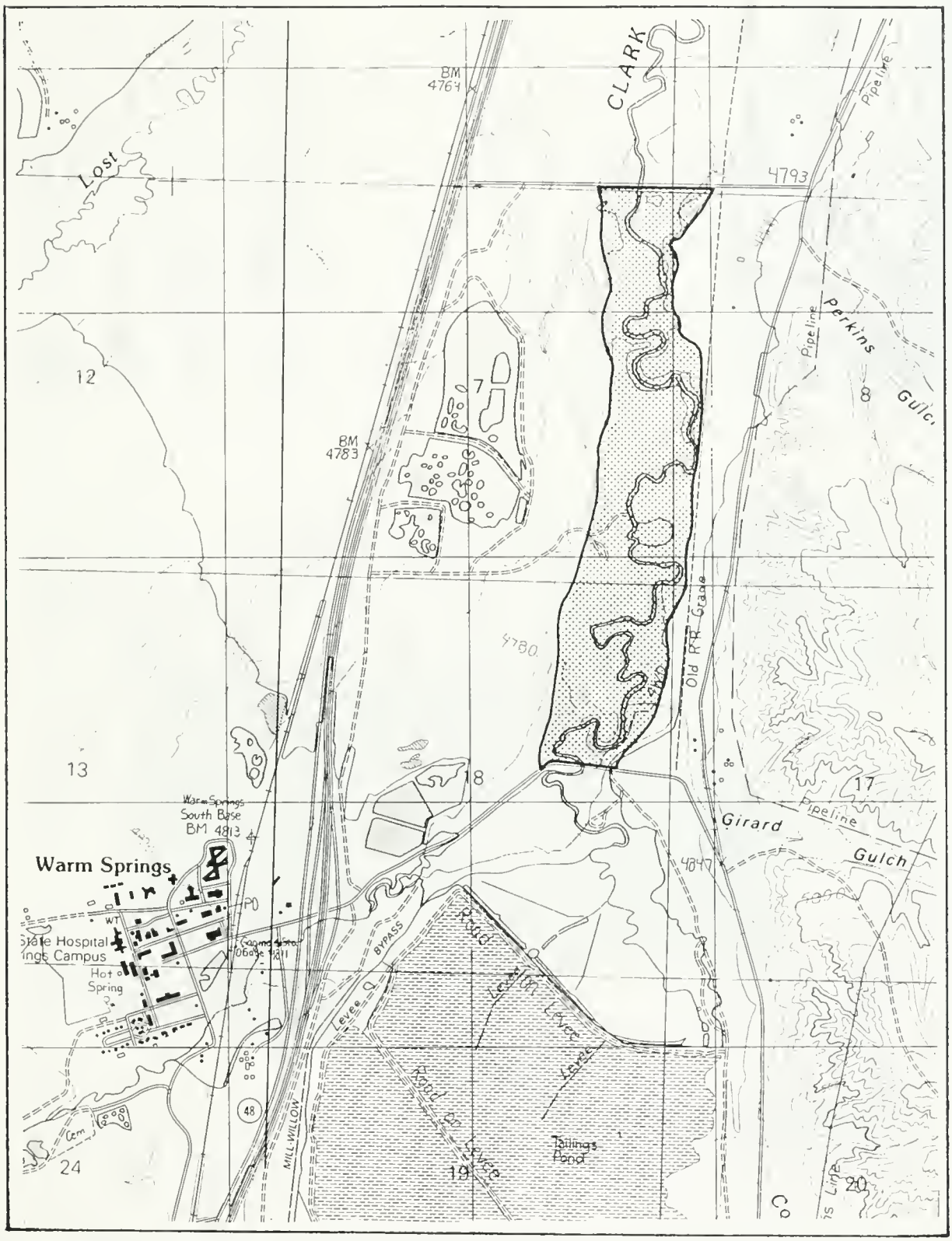
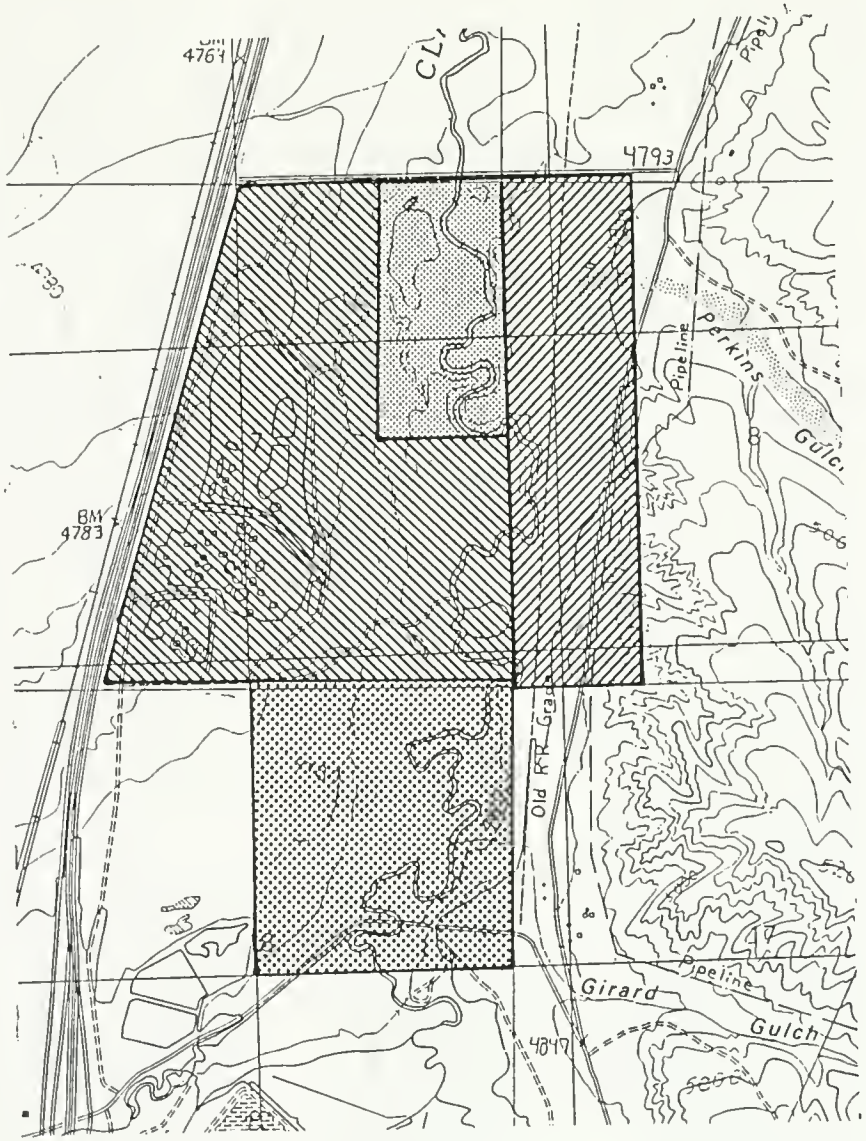


Figure 2.1 Location of the Clark Fork River Demonstration Project.



HANS LAMPERT

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MONTANA DEPT. OF FISH. WILDLIFE AND PARKS

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MILES

Schafer

CLARK FORK RIVER RECLAMATION PROJECT

LAND OWNERSHIP MAP

DRAWING A5700021

2.3 Site History

Numerous smelters operated in the Butte area around the turn of the century to process ore (Smith 1952). Early smelting processes generally consisted of pulverizing the ore to silt, sand, or small gravel- sized particles and then using gravity methods to separate the particles high in metal content from the waste rock or mill tailings (Smith 1952). Mill tailings were typically deposited behind dams located in adjacent drainages or were discharged directly to Silver Bow Creek. Locations of mill tailing deposits from early mining and milling activities in Butte are evident on maps and photographs contained in Weed (1897, 1912), and Meinzer (1914). Tailing dams along Silver Bow Creek would occasionally fail, and large quantities of tailings were carried downstream of Butte (GCM Services 1983). Flooding of Silver Bow Creek and the upper Clark Fork River was intensified by the abundance of tailings and waste dumped into Silver Bow Creek by mining operations in Butte. During flood events, tailings laden- water was spread over many of the irrigated areas. The mine wastes deposited were high in toxic metals and subsequently acidified floodplain soils.

Previous work in the basin by EPA contractors, Anaconda Company, and numerous State-funded projects has identified numerous environmental problems in agricultural lands, smelter damaged pasture and forest land, and contaminated surface and ground water. The water quality above the Warm Springs Ponds is too poor to support fisheries, though a substantial fishery thrives for a short distance below the Ponds. Water quality degrades again below the Ponds apparently due to localized contaminants sources. Elevated levels of Cu, perhaps Cadmium (Cd), and Zn during the winter cause increasing problems downstream. This increase in metals is often attributed to the effects of tailings in the channel, channel banks, or floodplain runoff across tailings deposits.

On occasion, metals concentrations in the river are high enough to be acutely toxic to fish. During the summers of both 1983 (August 9) and 1984 (August 1) large fish kills occurred in the upper Clark Fork River. Both events killed several thousand catchable brown trout and were associated with severe thunderstorms that caused sheet flooding of tailings deposits resulting in large quantities of metals entering the river. Gill tissue analyses of fish killed during the 1984 event confirmed that fish had been exposed to acutely lethal concentrations of copper (Phillips personal communication 1985).

On July 12, 1989 a large thunderstorm washed metals and sediment into the upper Clark Fork River resulting in a massive fish kill. Extensive water sampling at several locations along the Clark Fork indicated that metal levels climbed steeply and Ph dipped in response to the thunderstorm event, especially in the upper portions of the Clark Fork. Water quality data and fish bioassays (Phillips personal communication 1989) both indicate acute mortality due to metal poisoning (copper, zinc, and aluminum were all highly elevated in water). The number of dead fish was concentrated just below the Warm Springs Ponds and tended to decline downstream but tended to increase again below large tailings deposits below Perkins Lane bridge and below Deer Lodge.

2.4 Project Objectives

The objectives for the Clark Fork Demonstration project as stated by the Council are to:

> *"apply reclamation methods for streamside tailings to selected locations in the upper Clark Fork River. To demonstrate whether those methods are appropriate ... in other portions of the ... drainage. To achieve a long-term remedy to stabilize and/or neutralize tailings deposits as needed to improve or maintain water quality and habitat needed to support a healthy trout fishery."*

The work plan and project design developed by the project team represents what we feel, **at this time**, to be the most environmentally responsible and cost-effective method for improvement of the Clark Fork River. However, the project team recognizes that this method of reclamation, as well as other alternatives, must be evaluated by the Federal Superfund remedial process before a final remedy can be implemented.

3.0 PROJECT DESIGN

3.1 Project Planning

The success of a demonstration project depends, in great part, on realistic planning, and the efficient implementation of those plans. Much of the planning for this project was developed as part of our response to the request for proposal (Schafer 1989), and upon contract award, was immediately implemented. Included in this planning was literature review (including a number of studies by Schafer and Associates), field characterization, screening of remedial alternatives, and preliminary site selection. Only minor additional planning was necessary to complete a conceptual plan for committee and public review. The goals of the conceptual plan were:

- improve surface water quality,
- reduce the movement of heavy metals into surface and groundwater,
- enhance the fishery in the Clark Fork and specifically decrease the potential for fish kills,
- and preserve and enhance agricultural uses of the Clark Fork region.

In addition to a conceptual technical plan, preliminary unit cost estimates were developed, a preliminary site was selected, specific tasks were assigned to appropriate team members and initial goals established. Both short and long-term schedules were developed with critical tasks and milestones established. All this was completed prior to actual field work and site characterization (Schafer 1989).

3.2 Site Selection and Characterization

The project area, Warm Springs bridge to Perkins Lane, was selected as the site where the most effective improvement is fisheries was possible with the money available. This site is immediately below the Warm Springs Ponds where a project is under construction to improve the stability of the ponds and to remove tailings from the Mill-Willow bypass with subsequent improvement in water quality.

The logical strategy is to begin the Clark Fork clean-up at the upper end of the river to prevent potential re-contamination from future flood events. Other factors were also considered; 1) the number, size and proximity to the channel of tailings deposits (slickens) thought to directly contribute to fish kills; 2) the inclusion of tailings-contaminated areas within the project area that are "typical" of the remainder of the river; and 3) the likelihood of landowners willing to have the work performed on their property.

Much of the necessary characterization of the selected site was completed during

previous studies and in preparation for the proposal, although site specific tailings extent was less well known. The soil and tailings materials in the northern two-thirds of the project area, plus an area north of Perkins Lane bridge, was mapped in cooperation with the Deer Lodge Soil Survey party during the summer of 1988. The results of the mapping is reported in Schafer and Associates (1988). Intensive investigation (25 ft. grids) was completed on two sites within the survey area, and the lateral and vertical variability of tailings materials was determined through this data. Subsequently, a student at the University of Montana completed a thesis which involved mapping and lithological description of tailings deposits, and extensive chemical analysis (Nimmick 1990).

Other literature pertinent to the project included a forage establishment study in the Upper Deer Lodge Valley (Schafer 1988), and a treatability study on reclamation of mine waste for the Silver Bow Creek Superfund site (Phase I, II, and III Stars - Streambank Tailings and Revegetation Study, Schafer and Associates, Montana State University and CH_2M Hill, 1989a, 1989b, and 1989c and the Clark Fork River Screening Study, CH_2M Hill et al, 1990.

Additional site data was obtained by Schafer in March 1990 following initiation of the demonstration project. Five transects across the floodplain were located and 18 observation pits were excavated to depths below the static water level. All pits were carefully described and sampled, and ground water levels referenced. This data provided a general potentiometric surface for the project, as well as necessary soil samples for analysis.

Based on survey results, maps were produced showing tailings thickness and extent. These maps were used in conjunction with sample analyses to determine specific areas requiring deep plow tillage, agricultural tillage or top dressing.

The soil samples collected by Schafer, as well as selected samples collected by Nimmick, were submitted for analysis of sulfur fractions and acid base account in order to determine the amendment application rates. The intention of the design team was to add sufficient lime material to contaminated soils to permanently neutralize acidity. These tests allow the requisite lime rates to be predicted. The lime requirement was found to vary substantially throughout the site. A method was developed to generalize the lime requirement based on tailings thickness. All sample data were plotted as a function of tailings depth (Figure 3-1 and 3-2). In general, lime requirement was lower for surface samples than deeper samples because some of the pyrite in shallower layers has already oxidized causing a lower lime requirement. The maximum lime rate needed to neutralize 90 to 95 percent of the measured samples is depicted on Figure 3-1. The rates used were 25 tons of lime per 1000 tons of material for the upper 30 cm (1 foot) of tailings and 45 tons per 1000 tons for deeper tailings layers. A 6-inch layer of soil over 1 acre roughly equals 1000 tons.

An initial streambank survey was conducted in conjunction with the soil/tailings mapping projects (Schafer and Associates 1988) to delineate reaches where active erosion of thick tailings was occurring, or where thick tailings adjacent to the channel provided a potential source for future contamination. Streambank condition was rated according to

bank angle, percentage of protective cover, kind of cover and depth of tailings. A more intensive survey of the river system was conducted in March 1990 by members of the project team. Features delineated during the survey included channel bedforms directing the flow towards erosive areas, areas where excessive grazing by cattle were causing accelerated erosion, entry of overbank flood-chutes, side channels and headcut areas, and locations of overland flow rills and gullies. From this survey, specific areas were delineated for modification, regrading or sediment control structures.

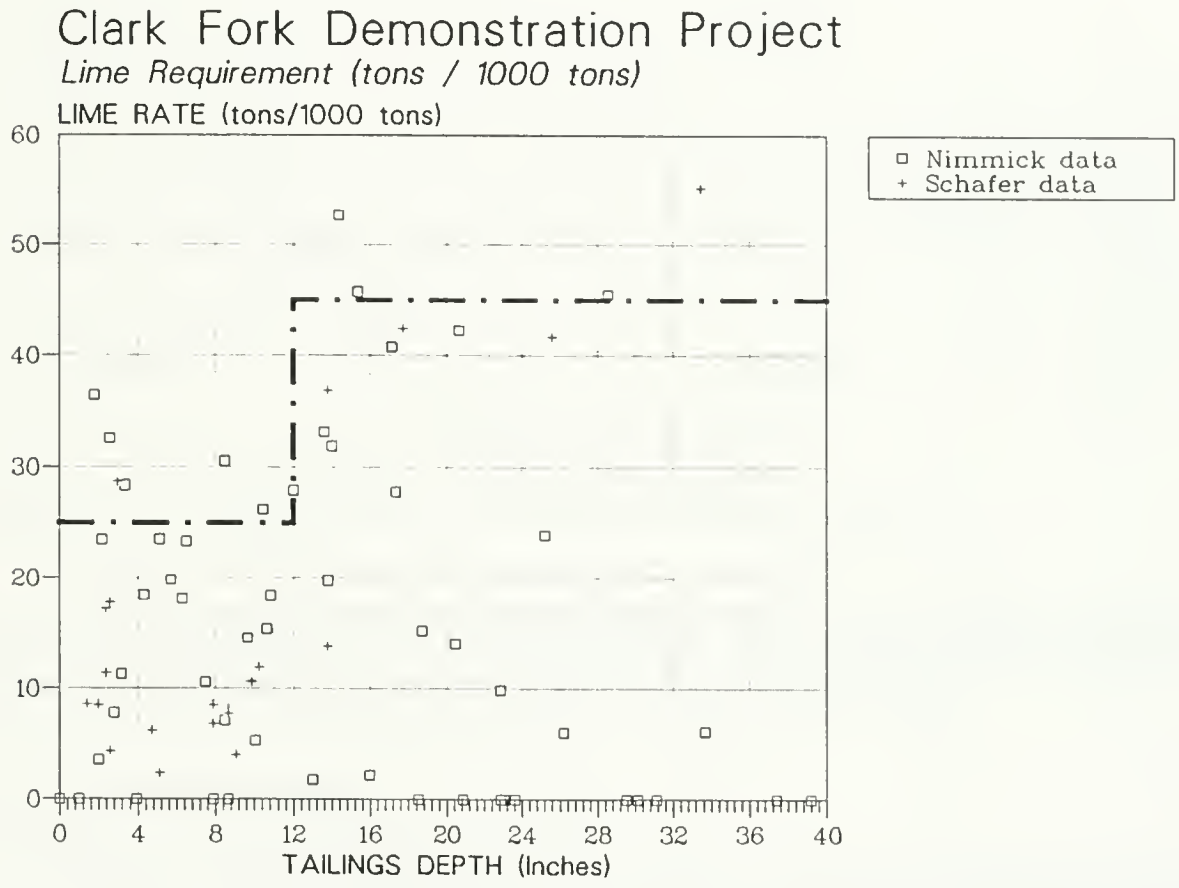


Figure 3-1. Computation of lime requirement for tailings within the Clark Fork Demonstration project area.

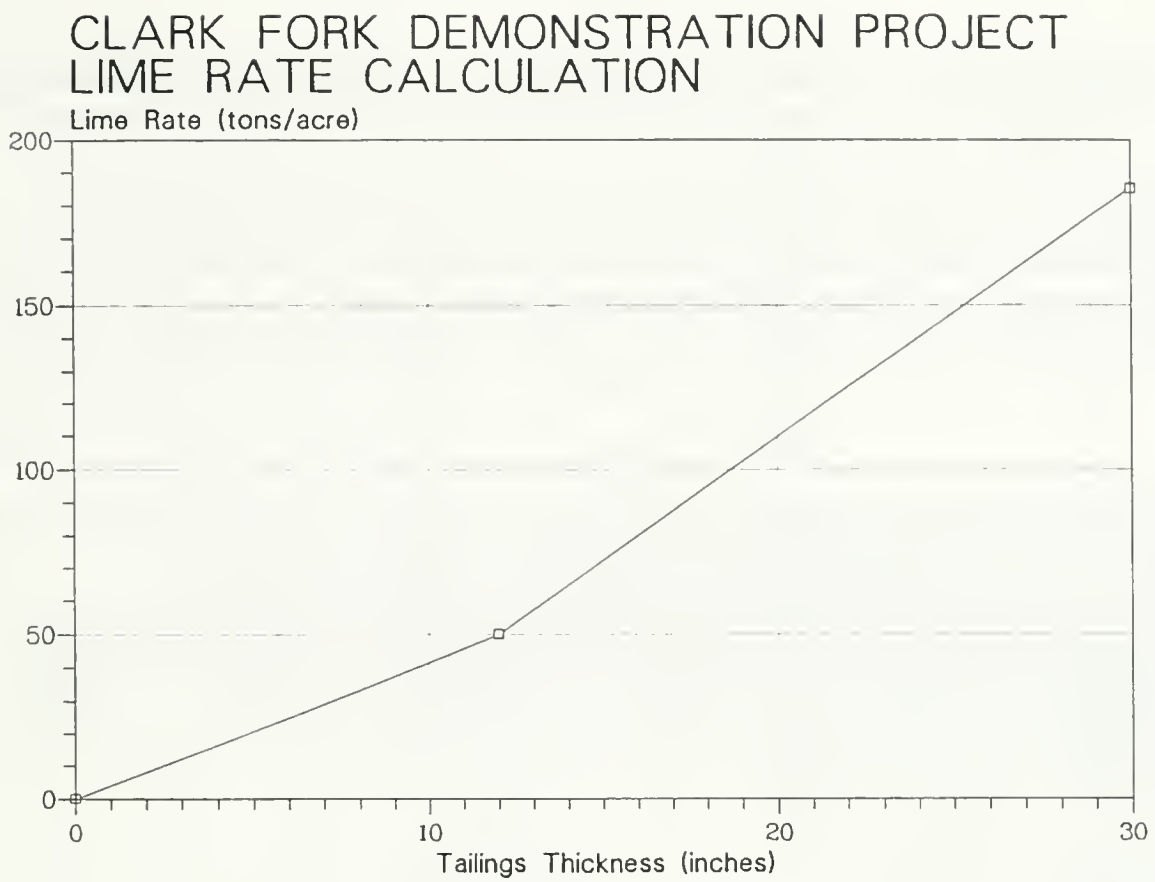


Figure 3-2. Computed lime rate as a function of tailings thickness.

An aerial survey was conducted by Horizons, Inc to provide detailed topographic information for the project area. Additional ground survey work was also completed to locate utility corridors, soil/tailings survey pits and water surface levels.

3.3 Design Framework

The final project design focused on the chemical neutralization of tailings, reduction or elimination of scour areas (where erosion is prevalent during out-of-bank flood events), control of surface flows, and re-establishment of stable streambanks along a riparian corridor, and minor stream channel improvements to protect the fisheries and enhance forage production within the project area. From the site characterization, a work plan was developed and costs applied to the work items to determine the extent of the work area. Final design was then completed.

Tailings neutralization was accomplished by applying lime at the determined rates and incorporating the lime into the soil by deep plow or agricultural tillage, depending on the depth and extent of the tailings. Deep tillage was found to be an effective means of mixing lime with tailings in prior EPA investigations (Schafer and Associates et al. 1989b). Regardless of the incorporation method, a minimum of two tillage passes were required to

insure thorough mixing of lime with the tailings. For deep plow areas, a portion of the lime was retained for surface treatment to insure conditions conducive to plant growth.

Tailings areas of less than 4 inches in depth generally had vegetative cover, and were to receive a surface application of 8 tons/acre lime only, with no incorporation. For tailings 4 to 12 inches thick, lime would be applied in one lift at 50 tons/acre and incorporated with two passes of agricultural tillage. For tailings thicker than 12 inches (to 30 inches), lime would be applied in staged lifts and incorporated with a minimum of two passes of deep plow tillage plus two passes of agricultural tillage (Table 3-1).

Table 3-1. Lime rates used for varying tailings thickness zones.

LIME APPLICATION RATES/TILLAGE METHOD FOR VARIOUS TAILINGS THICKNESSES					
Tailings Depth (In)	Total Lime Rate T/AC	Lime Incorp. (Tillage) Method	No. of Tillage Passes	Lime Amounts per lift T/AC	Lime Retained for Topdress T/AC
0 - 4	8	none	0	8	0
4 - 12	50	agriculture	2	50	0
14	65	deep plow	2	40	25
16	80	deep plow	2	55	25
18	95	deep plow	2	70	25
20	110	deep plow	2	45,40	25
22	125	deep plow	2	50,45	30
24	140	deep plow	2	55,50	35
26	155	deep plow	2	60,55	40
28	170	deep plow	2	65,60	45
30	170	deep plow	2	65,60	45

During the stream survey, approximately 20 locations were identified as requiring streambank work which involved 1) removal of tailings from the immediate streambank scour area and placing away from the river, 2) reconstruction of the streambank using clean material, 3) construction of a temporary dike (from clean material) between the tailings and the regraded bank, 4) lime application, 5) completion of grading, and placement of coconut erosion control mat. The regraded areas would be sprigged with willow shoots at the appropriate time (spring, 1991).

Surface water will be controlled with straw-bale sediment control structures located where overland flows re-enter the Clark Fork River. These structures are designed to provide short-term sediment control for disturbed areas until vegetation is established, and are sized according to runoff area.

Prior to revegetation, all disturbed areas will be graded to provide positive drainage to the sediment control structures and a smooth, natural surface. Disturbed areas will then be fertilized, seeded and mulched to re-establish a ground cover of grasses. All regraded streambank areas, as well as other selected areas, will be sprigged with willow shoots at the proper time. Figure(s) 3.3a through 3.3e show a schematic of the sequence of operations for the project design.

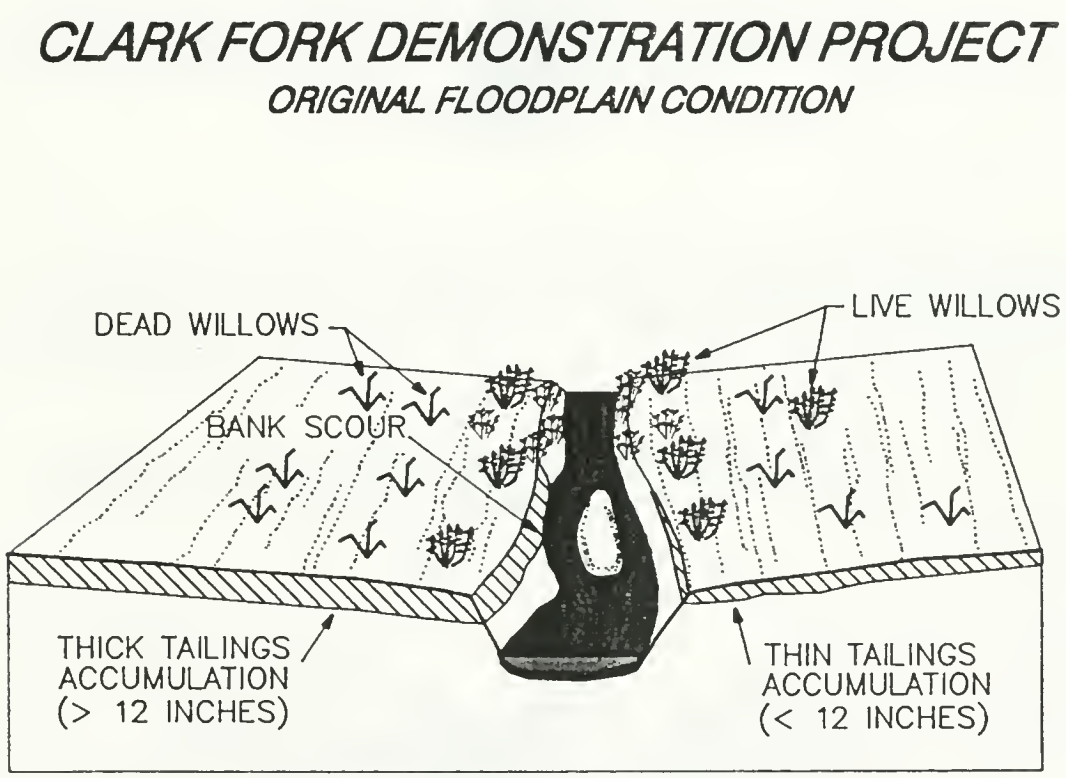


Figure 3.3a. Schematic of a portion of the Clark Fork River floodplain showing damaged streambanks, aggrading channel areas, and denuded upland areas.

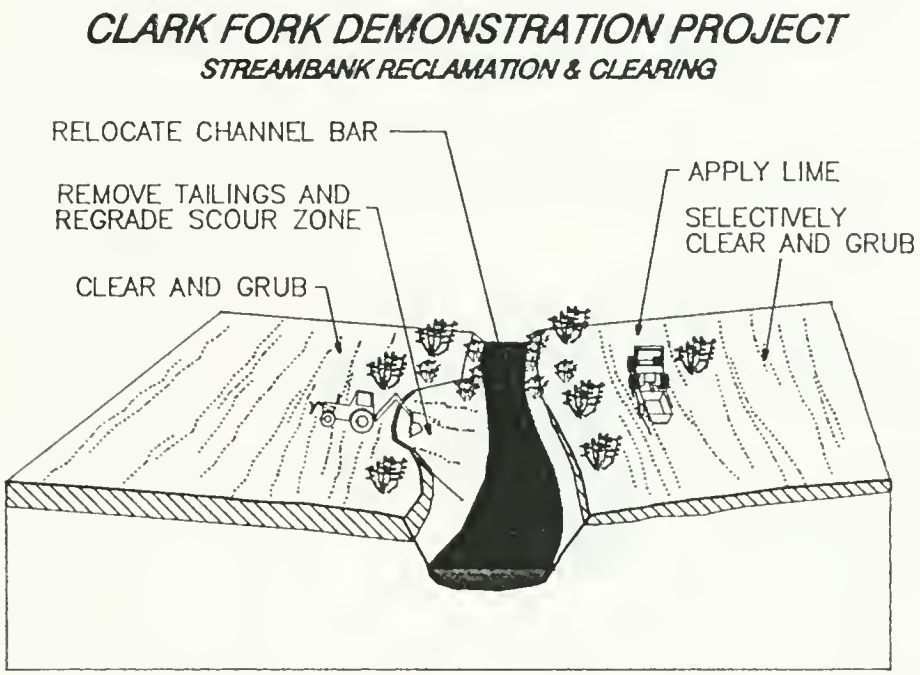


Figure 3.3b. In the initial stages of reclamation, tailings are removed from eroding streambanks and channel modifications are provided, dead vegetation is cleared and lime is spread.

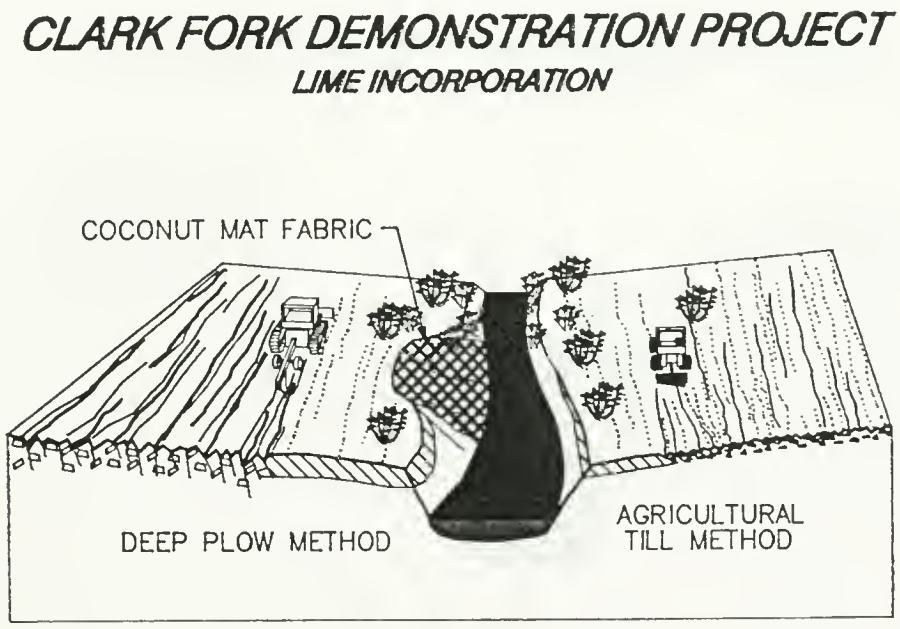


Figure 3.3c. Next the reshaped streambanks are seeded and protected with coconut fabric, lime is incorporated by deep tillage on thick tailings and by agricultural tillage in thinner tailings areas.

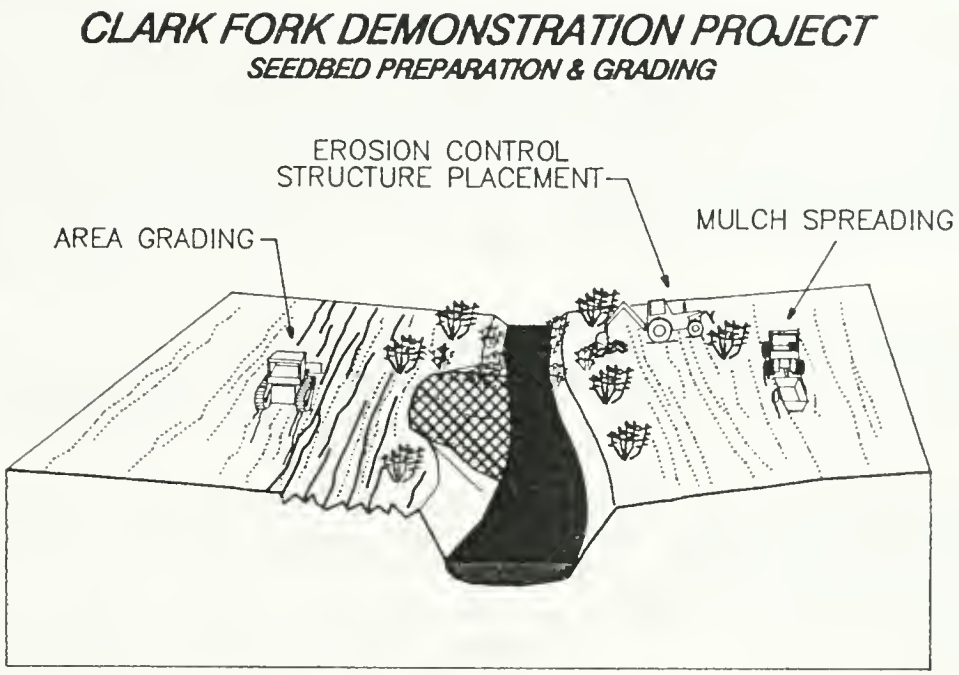


Figure 3.3d. After application and incorporation of lime, soils are regraded to prepare a seedbed and are mulched to provide erosion protection until seeding is permissible. Erosion control structures are constructed during final grading.

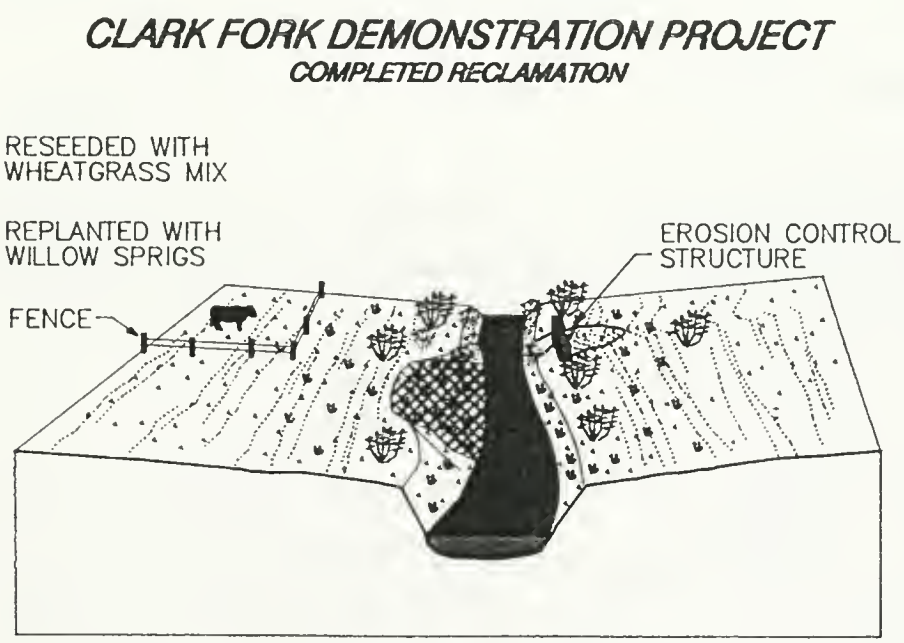


Figure 3.3e. Finally all disturbed areas are seeded, roads are removed, fences are installed, and post-reclamation management insures continued health of the landscape.

3.4 Engineering Plans

Detailed reclamation plans for the project area were developed following site characterization. These plans specifically identify the locations and types of work to be completed, as well as areas, quantities, access routes and staging areas. Areas of clear and grub, deep plow tillage and agricultural tillage are delineated, and specific lime requirements are shown for each area. A detail sheet was included to detail the erosion control structures, streambank modifications and meander loop work (see Clark Fork Request for Proposals, Schafer and Associates 1990).

The plans were developed using a combination of computer-assisted engineering and design (CAE/CAD) techniques and mechanical drafting to simplify any revision to the plans and aid in development of as-built drawings.

Specifications were developed describing work methods to be used for each defined type of work for the Demonstration project. Acceptable means were developed for measuring the amount of work performed for determining payment for each work item. Typical measurement and payment methods include lump sum for mobilization, per acre of clearing and grubbing, or per foot of fence installed.

3.5 Cost Estimate

Upon completion of the project design and plan drawings, a detailed cost estimate was prepared to compare the cost of the proposed work with the construction budget. The estimated cost of the proposed work was $560,297 (Table 3.2).

Table 3.2. Engineers estimated cost for work items in the Clark Fork Demonstration project.

Item No.	Estimated Quantity	Unit	Description	Unit Price	Total Price
1.	1	L.S.	Mobilization	XXXXX	25,000
2.	100	cu. yd.	Salvage & Replace Topsoil	XXXXX	500
3.	18	acres	Clearing and Grubbing	1,200	21,600
4.	1	L.S.	Debris Removal	XXXXX	1,000
5.	1,900	KGal	Provide Water	10	19,000
6.			LIME APPLICATION		
6a.	7,269	tons	ECCE in place	28	203,532

Item No.	Estimated Quantity	Unit	Description	Unit Price	Total Price
6b.	40	acres	Top Dressing	0	0
6c.	152	acres	Agriculture Tillage	50	7,600
6d.	104	acres	Deep Tillage	420	43,680
7.	76	acres	Area Grading	150	11,400
8.			STREAM MODIFICATIONS		
8a.	105	hours	Track-Mounted Excavator	75	7,875
8b.	235	cu. yd.	Rip-Rap	40	9,400
9.	92	acres	Fertilize and Seed	400	36,800
10.			MULCH		
10a.	76	acres	Summer Erosion Control	600	45,600
10b.	92	acres	Vegetative Mulch	900	82,800
10c.	4800	sq. yd.	Erosion Control Blanket	2	9,600
11.			FARM FENCE		
11a.	20000	lin. ft.	Farm Fence Type F-4M	0.90	18,000
11b.	30	each	Single Panels	75	2,250
11c.	40	each	Double Panels	90	3,600
11d.	160	lin. ft.	Type G-2 Gate (16 ft./gate)	6	960
11e.	18	each	Stock Panels	100	1,800
12.			EROSION CONTROL STRUCTURES		
12a.	35	each	Small Structures	100	3,500
12b.	18	each	Medium Structures	200	3,600
12c.	4	each	Large Structures	300	1,200
TOTAL BASE BID:				**$ 560,297.00** (price in numbers)	

3.6 Landowner Access

Following preliminary selection and approval of the project area, landowner contacts began. Partial ownership of the project area by ARCO Coal and Fish, Wildlife and Parks not only influenced the site selection, but also simplified access. Using information provided by ARCO, two other landowners within the project area were identified, namely Hans Lampert and Duane/Kathleen Logan.

The landowners were then contacted and interviews set up to explain the project, and determine their interest in the project. All landowners were receptive to having the work performed on their property. A License Agreement For Reclamation Work was developed and signed by the landowners. This agreement allowed the reclamation work to be done at no cost to the owner, provided continuous access was allowed and the landowner would manage the reclaimed areas for three to five years in a manner that will allow vegetation to become established (grazing management plan). In addition, the agreement holds the landowner harmless for any claims, demands, injuries, damages or liabilities arising out the work, and compensates the landowner for loss of grazing associated with the work.

3.7 Permits

A number of permits were applied for, and received, prior to project construction. These permits include a 124 Permit from the Montana Department of Fish Wildlife and Parks (Montana Stream Preservation Act), a 310 Permit (Natural Streambed and Land Preservation Act), a 3A Permit from the Department of Health and Environmental Sciences, a 404 Permit from the U.S. Army Corps of Engineers and a Flood Plain Permit from Department of Natural Resources and Conservation.

Other regulatory approval received included an Environmental Assessment from Department of Fish, Wildlife and Parks and approval from the Montana Air Quality Bureau for open burning with a burning permit (obtained by the contractor). Copies of these permits are found in Appendix A.

3.7 Public Review and Site Tours

Public review and comment has been an on-going process throughout the Clark Fork Demonstration project. A number of public meetings, news releases, and site tours were conducted during the project (Table 3.3) and additional tours, meetings, and publications are planned.

Table 3.3. Public participation and review opportunities provided during the Clark Fork Demonstration project.

DATE	EVENT	PARTICIPANTS
January, 1990	Public Meeting to introduce project in Anaconda, MT	Roughly 80 attended from the public at-large
February, 1990	Public meeting to describe project design	About 30 participants including public, media, and agency
March, 1990	Trout Unlimited meeting, George Grant chapter	About 35 TU members attended
May, 1990	Field tour with Governor Stephens	Roughly 50 media representatives, state officials, and agency staff
April, 1990	Clark Fork newsletter	Over 100 individuals on mailing list received information on project
June, 1990	Participated in field tour of berming project to describe the Clark Fork Demo project to participants	About 12 agency and regulatory staff, and ARCO
July-October, 1990	Numerous informal field tours conducted for interested individuals from EPA, MDHES, ARCO, consultants	Varied

Table 4.1. Proposal ranking criteria used by all members of the contractor selection committee.

RANKING ITEM	RATING[1]	WEIGHT	SCORE
a. Experience in performing similar work		6	
b. References of three clients for similar work		4	
c. Understanding of special work conditions which may be encountered on site, and of environmental restrictions inherent to the project		3	
d. The use of specialized equipment		5	
e. Present and future (projected) workload		2	
f. Cost and time schedules		5	
Total points			100

[1] - Rating system; 4 - Clearly outstanding; 3 - Highly qualified; 2 - Acceptable; 1 - OK; 0 - Clearly unsatisfactory or unknown.

Table 4.2. Cumulative scores for submitted proposals.

SELECTION COMMITTEE MEMBER	MUNGAS	JORDAN	AJAX	DONNES
Ray Tillman	85	63	82	60
Glen Phillips	75	90	74	61
Haley Beaudrey	90	95	85	67
Bill Schafer	73	83.5	52.5	57.5
Gary Rome	62	64	50	47
Total	385	395.5	343.5	292.5

4.3 Contractor Selection

Because of the complexity of the project, selection of a contractor was determined by proposal, and not by lowest responsible bidder. The contractor whose proposal constituted the best combination of both costs and technical ability was selected to perform the work. Members of the ranking committee included Ray Tillman, Montana Resources;

Glen Phillips, Department of Fish, Wildlife and Parks; Haley Beaudrey, White Resources; Gary Rome, Spectrum Engineering; and Bill Schafer, Schafer and Associates.

Four contractors submitted proposals, namely Jordan Contracting, Inc. (Anaconda, MT), Donnes Inc. (Billings, MT), Mungas Co. Inc. (Phillipsburg, MT), and Ajax Contracting, Inc. (Victor, MT). All four contractors were deemed responsible bidders, and were ranked as shown in Table 4.2. Jordan Contracting, Inc. received the highest combined score.

4.4 Negotiations

Negotiations were initiated with Jordan Contracting, Inc. (Jordan) on June 22, 1990, with Mr. William Schafer (Schafer) meeting with Mr. Joe Jordan (Jordan) and Mr. Bernie Jensen (Western Reclamation). A misunderstanding of the liming requirements resulted in Jordan's proposal price for lime being approximately $58,000 high (total bid price $629,212.66). The quantity of lime required under the contract was based on the purity of calcium carbonate. A portion of the lime to be provided consisted of calcium oxide which is 1.7 times more effective than calcium carbonate which resulted in Jordans overestimate of the needed quantity of lime. A revised proposal price was negotiated at $571,575.58.

An Agreement and Notice of Award for $571,575.58 was issued to Jordan Contracting, Inc. on June 29, 1990 and signed by Mr. Joe Jordan on July 5, 1990.

4.5 Contractual Guaranty

Jordan Contracting, Inc. produced Irrevocable Letter(s) of Credit in favor for the account of Jordan Contracting, Inc. for Performance Requirement and for Labor and Material Requirement, to be "Drawn Under First Security Bank of Anaconda, First Bank Place, Anaconda, Montana 59711-0061, Credit #06271990-1". These letters were accepted in lieu of the bonding required in the Bid Documents. In addition, Certificates of Insurance were also produced.

5.0 PROJECT CONSTRUCTION

5.1 Pre-Construction Meeting

A pre-construction meeting was held on June 29, 1990 with Bruce Parker and John Goering (Schafer), Joe Jordan and Russ Martin (Jordan), and Bernie Jensen (Western Reclamation) in attendance. Items discussed included administrative issues, lime and construction requirements.

Some specific key issues addressed were contractor submittals, insurance requirements, separate Letter(s) of Credit for performance, and labor and materials, Health and Safety Plans, and lime analyses requirements. Construction items included work delineation, construction staking, salvaging of healthy willows, lime quantities per work area, change order and work directive procedures, and Jordan delegation of authority to shift foreman.

5.2 Operations

The operations phase of the project involved the actual construction and reclamation work. Work items completed included access and staging area preparation, clearing and grubbing, lime delivery, application, and incorporation (deep plow tillage and agricultural tillage), tailings removal from streambank scour areas and subsequent treatment, streambank regrading/reconstruction, channel modifications, erosion control mat installation, sediment control structures, area grading, seeding, fertilizing and mulch, and fencing (see figures 3.3a through 3.3e).

Access was modified and staging areas prepared in all work areas at locations suitable for delivery of lime materials consisting of both calcium oxide (CaO) and calcium carbonate ($CaCO_3$). All calcium oxide material was received from Continental Limestone at Townsend, Montana, and all calcium carbonate material was received from Montana Limestone at Warren, Montana. Submittals from both operations confirmed product specifications.

Approximately 26 acres of clearing and grubbing was required to prepare the project area for liming and other work. Every effort was made to save areas of healthy willows, particularly in areas where overland flow was evident. With the exception of streambank modification locations, a strip of willows was left intact along the entire stream corridor within the project area. At these locations, healthy willow clumps were replanted as part of the streambank work where feasible.

Calcium oxide and calcium carbonate was applied in separate operations. Areas of tailings with depths less than 12 inches, and little or no vegetative cover, had a single lift of lime applied at 50 tons/acre and incorporated with a minimum of two passes of agricultural tillage. Vegetated areas of less than 4 inches of tailings were left undisturbed, or received a minimal amount of lime top dressing.

Areas of tailings greater than 12 inches received staged, multiple lifts of lime at rates ranging from 65 to 170 tons/acre. Incorporation required a minimum of two deep plow tillage passes and two agricultural tillage passes. A portion of the lime in the deep plow areas was retained for top dressing to insure a surface condition conducive to plant growth. Subsequent tillage passes, both deep plow and ag till, were performed at near perpendicular direction to the previous passes, where feasible, to provide the maximum mixing possible. A total of 7271 tons of lime (ECCE) was used during the project, and a total of about 156 acres of agricultural tillage, and 111 acres of deep plow tillage, was completed during the project.

Approximately 3200 linear feet of scoured and/or potentially erosive streambank were reconstructed during the project. The conceptual design called for removing the tailings from the eroding streambank areas and depositing them in a more stable location away from the river. The removed tailings will then be treated with lime in sequence with the tillage areas. Following tailings removal, the banks would be regraded and/or reconstructed as necessary to produce a stable slope of approximately 3 horizontal:1 vertical. Often times, tailings were 4 to 5 feet thick in the scour areas requiring over-excavation for complete removal of tailings. When this condition existed, suitable material was imported from selected borrow areas within the project area to adequately reconstruct the streambank.

Live willow clumps were incorporated into regraded streambank areas where feasible. The streambanks were seeded with a mixture of species suited for streambank areas. Coconut erosion control mat applied, keyed into the soil, and fastened as a final step. At selected locations, portions of the regraded streambanks were armored with gravel taken from the bottom of the stream channel.

The river channel was modified at approximately eleven locations within the project area. Channel areas were modified where structures within the channel (islands, bars and man-made objects) were directing flow into actively eroding streambanks. Where possible, modifications created riffles, runs, holding water or other features favorable as fish habitat.

Following lime incorporation, the entire project area was regraded in an effort to produce a more suitable working surface for revegetation activities, to provide positive drainage to sediment control structure locations, and to produce a more natural surface appearance by blending with adjacent contours. Following area grading, sediment control structures were constructed in locations where overland flow would re-enter the river, i.e. swales, rills and gullies. The structures were constructed according to the plans and were field adjusted for both location and size as necessary. A total of 8 large, 23 medium and 24 small structures were constructed.

All disturbed areas within the project area were reseeded, fertilized and mulched at the completion of work. These areas included staging areas, access roads, lime stockpile areas, and borrow areas, as well as the reclaimed tailings and streambank areas. Seeding took place after October 15, following application of fertilizer and mulch. Fencing of riparian corridors was completed in conjunction with seeding operations. Included in the fencing was short stretches of fence to restrict unwanted vehicle traffic. Willow sprigging operations will commence in the late winter/spring 1991 season.

Other work operations completed during the project included debris removal such as bridges, fuel tanks and drums, abandoned fences, and junk vehicles and other man-made objects. The project also included the construction of a boat ramp, and construction or enhancement of wetland areas for waterfowl and other wildlife habitat.

5.3 Equipment

Equipment used on the project included both standard construction and farming equipment, as well as equipment specifically designed and built for this type of work. A list of equipment used on the project follows:

Standard Equipment

1. Caterpillar D8K w/ 12 ft. dozer blade or brush rake (250 HP)
2. Caterpillar D7 with 12 ft. dozer (185 HP)
3. Caterpillar 966 B14 wheel loader w/ 4 cy bucket (95 HP)
4. Caterpillar 950 wheel loader w/ grapple bucket (60 HP)
5. Caterpillar 12E patrol w/ 12 ft. mold board (95 HP)
6. John Deere 690 10 track-hoe w/ 1 1/2 cy bucket (145 HP)
7. John Deere 410 wheel loader/backhoe (48 HP)
8. Mack dump truck, 12-14 cy
9. Mack water truck (3600 gallon tank)
10. Kenworth transport, 40 ton
11. Euclid 71-10 wheel loader w/ 1 3/4 cy bucket
12. John Deer 4430 farm tractor (125 HP)
13. John Deere 2030 farm tractor (70 HP)
14. International 4366 4WD farm tractor (175 HP)
15. Finn hydroseeder and truck (1500 gallon tank)
16. Crimper

Specialized Equipment

1. John Deere 540B lime spreader, 7 cy (100 HP)
2. Schafer disc plow w/ 32 inch discs
3. Case lime spreader (pull-behind), 6 cy w/ floatation tires
4. Custom built seeder tractor w/ floatation tires
5. Custom built straw spreader
6. Custom built deep plow

All clearing and grubbing was completed with crawler type tractors equipped with brush rakes or four-wheel drive loaders equipped with grapple buckets. Deep plow tillage and all area grading was completed using the Caterpillar tractors. Lime spreading was completed with custom built lime spreading equipment specifically designed to perform work on wet tailings areas. Agricultural tillage was completed using a 32" disc pulled behind a 4WD farm tractor. All stream channel work, and a majority of the streambank work, was completed using a John Deere 690 trackhoe. All sediment control structures and a minor portion of the streambank work was completed with the John Deere 410 backhoe. Seed, fertilizer and mulch were completed using a combination of standard and specialized equipment.

5.4 Supervision

Construction supervision was provided continuously during the project construction phase for all the liming application and incorporation, during all streambank and stream channel work, and for a majority of the sediment control structure construction and erosion control mat placement. Supervision was by a Montana Registered Professional Engineer with assistance from qualified, experienced technicians. During the peak of the construction activities, two supervisory personnel were required to maintain quality control. During the final stages of the project when "unit price" construction activities (i.e. sediment control structures, erosion control mat, fencing, seed, fertilize and mulch, and debris removal) were being completed, the decision was made that full-time supervision was not necessary, so supervision was reduced to approximately one-half time, with resulting savings to the project.

Responsibilities of the supervisor/inspector included construction staking, site-specific decisions regarding additional clear and grub areas, confirmation of lime quantities and application rates, locating and direct supervision of all streambank and stream channel work, locating sediment control structures, confirmation of tillage methods and operations, inspection/supervision of sediment control structure construction and erosion control mat installation, debris removal, and fence locations.

Other activities included liaison with landowners, regulatory personnel, Fish, Wildlife and Parks personnel, ARCO Coal personnel, and the public. Special tasks and activities included location and supervision of wetland reconstruction, location and supervision of boat ramp construction and coordination of activities between the contractor, subcontractors and outside parties.

5.5 Project Completion

The original project completion day was scheduled for October 11, 1990, but due to project delays through 404 Permit acquisition and weather, and a work shutdown due to unacceptably dry seedbed conditions, the project completion was delayed approximately 30 days, or until November 15, 1990.

Substantial completion was requested by Jordan and approved by Schafer on October 31, 1990. A final punchlist was prepared listing work items requiring changes, modification or completion, and given to Jordan. At the same time, a mandatory work shutdown order was initiated because of dry seedbed conditions, and the project was placed on hold pending sufficient moisture. Sufficient moisture was received by November 12, 1990, as determined by Schafer in consultation with Mr. Jensen, and work on the project resumed on November 13, 1990. All work, including seeding, was completed on November 15, 1990. A final inspection was completed on November 23, 1990.

5.6 Organization/Schedule

The final project schedule and milestone accomplishments is shown in Figure 5.1.

5.7 As-Built Drawings

The Clark Fork project was funded to demonstrate the use of reclamation techniques for remediation of the upper Clark Fork River. As such, it is important to identify any changes in project design mandated by practical construction considerations. These changes will be used to modify subsequent reclamation plans and specifications, and aid in future project designs. All changes from the original plans are shown on as-built drawings contained in Appendix B.

5.8 Construction Management

The purpose of this section is to identify problems encountered during project construction, selected remedies, and potential cost-saving methods tried or recommended. Overall, the project was completed nearly as designed, with the exception of restoring the river into the abandoned meander. Only minimal problems were encountered during the course of the project.

Lime: Of the minor amount of problems that did occur, most centered around the lime, especially handling, supply and stockpiling of calcium carbonate. The calcium oxide (CaO) portion of the lime requirements was obtained from Continental Lime at Townsend, Montana, and was transported by Jordan trucks to the staging areas. No problems were encountered with this product. The calcium carbonate ($CaCO_3$) portion was obtained from

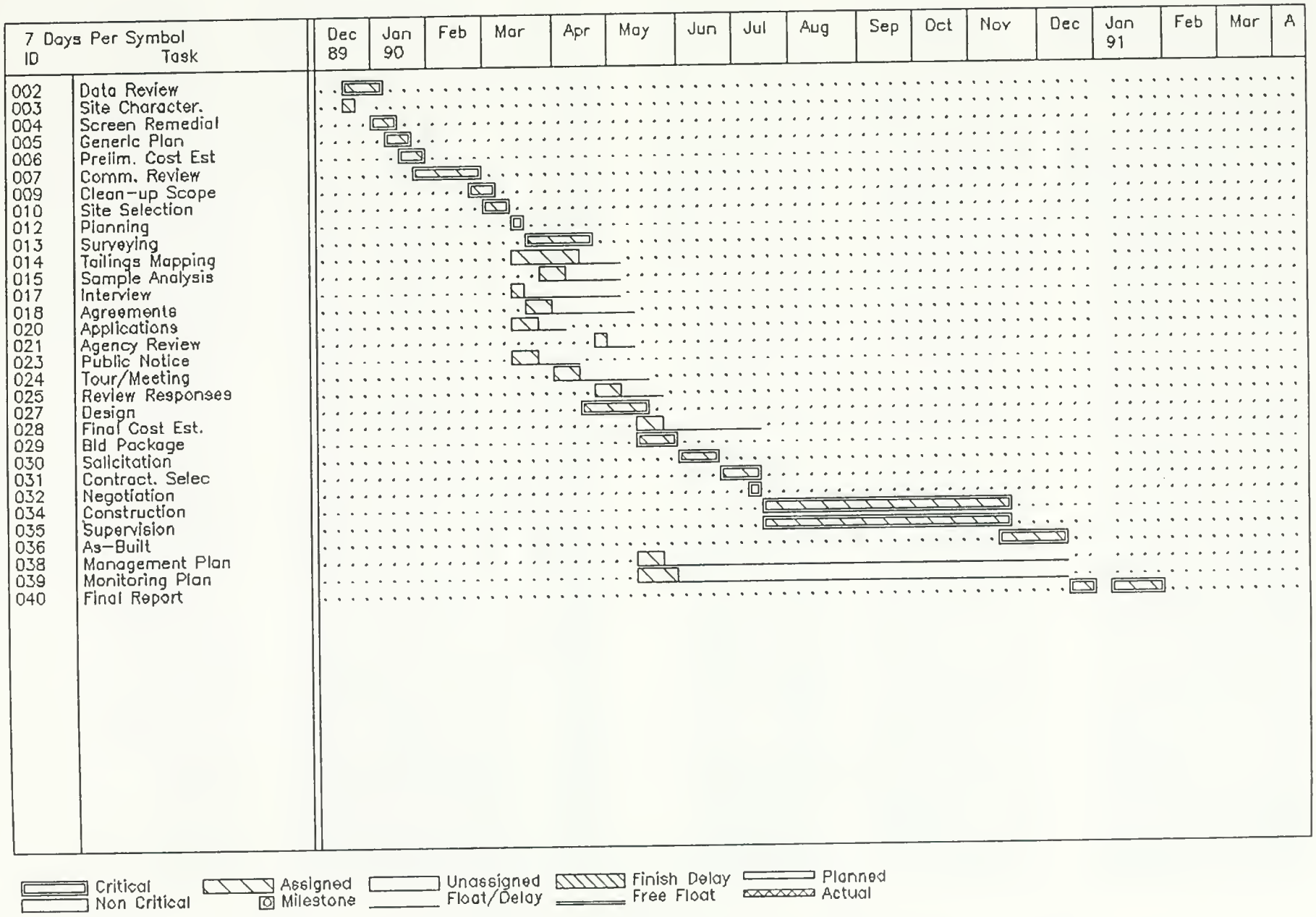


Figure 5.1. Actual schedule for completion of the Clark Fork Demonstration project.

Montana Limestone in Warren, Montana (approximately 100 miles southwest of Billings), and was transported using "over-the-road" trucks with trailers. Prior to shipment, all staging areas were approved by a representative of Montana Limestone, however, upon delivery, the trucks had difficulty getting into the staging areas, off-loading in the correct stockpile locations, and with getting the trucks stuck in the loose soil. Delivery of sufficient quantities of $CaCO_3$ became a problem on several occasions, as well. In an effort to alleviate some of the delivery problems, staging areas were located closer to county or other public areas, which in turn created some minor problems with the lime materials becoming easily accessible to the public.

The problems associated with the lime delivery were alleviated by relocating the stockpile locations in more accessible locations, and by making the driver's more aware of the problems created by not delivering the lime materials to the proper location. This created more rehandle and longer hauls (from the stockpile to the work areas) for Jordan, and allowed the public greater access to the lime. All lime stockpile areas were signed to inform the public of the hazard of the material. In addition, sufficient quantities of lime to maintain production was supplied by making arrangements to haul on the weekends.

On future projects of this nature, lime transportation and handling would be more efficiently handled by transporting the lime materials, by rail, to a local railroad siding, and finally from the siding to the stockpile areas with smaller, covered trucks. This method would be less expensive,and would allow for smaller, localized stockpile areas, less site work for preparing access roads, would more likely ensure sufficient quantities, and would reduce public access to the material.

Streambank Work: Problems associated with the streambank work were generally site-specific and difficult to anticipate or predict. Several methods were employed to successfully handle the unexpected conditions and complete the work.

Tailings were anticipated to be about 20 to 30 inches in depth in the streambank regrade areas, which proved to be true in most locations. At several work locations, tailings depths were found to be in excess of 5 feet in depth, requiring over excavation of the streambank to sufficiently remove the tailings. Clean fill material was imported to these locations, and the streambank rebuilt, compacted, and covered with coconut erosion control fabric. The toe of the reconstructed bank was then armored with cobbles and gravel, and clumps of live willows transplanted, where feasible, to further protect the bank. The toes of several other regraded streambanks were also armored where deeper water, or stronger current was present.

Prediction of tailings depths at each area selected for streambank work would be nearly impossible without excavating test pits at each site, which is impractical for a project of this size and complexity. It is recommended to locate suitable borrow sources of clean material within the project boundaries where possible in anticipation of this.

It is recommended that the streambank regrading work be completed prior to the liming and tillage operations, as were the majority of the streambank reconstruction areas for this project. This allowed the removed tailings to be treated in conjunction with the other tailings, eliminating the need to go back and lime the additional tailings. As a demonstration, several streambanks were reconstructed after treatment of adjacent tailings areas, and results and work methods compared. Because of the scheduling and logistic difficulties associated with the additional passes of lime and equipment, and the degree of mixture, it was determined that completing the streambank reconstruction work prior to the liming operations was indeed the best method.

Hunting Season: Minor problems were encountered during the fall hunting season along the project area, mainly with excessive vehicle traffic in areas of completed reclamation, and the potential of stray shots. Several incidents occurred where individuals were driving their vehicles in reseeded or reclaimed areas, or where shots were fired in the vicinity of the construction crews.

Fish, Wildlife and Parks personnel were contacted and immediately put up notices and signs restricting vehicle traffic, and limiting hunting to archery, muzzleloader or shotgun. In addition, workers were asked to wear hunter orange clothing.

Cattle/fencing: At locations where fences cross the river, breaching cattle have historically affected bird nesting areas within Fish, Wildlife and Parks property.

In an effort to reduce the number of fence crossing locations in an area where cattle are prone to walking around the end of the fenced panels, a "land/grazing swap" was initiated between Fish, Wildlife and Parks (FWP) and Duane Logan. A portion of land belonging to FWP, comprising about 4.5 acres, was fenced and Logan's cattle will be allowed to graze it. In return, FWP will receive use of approximately 1.5 acres of riparian habitat and at the same time eliminate four locations where fences were to have crossed the river.

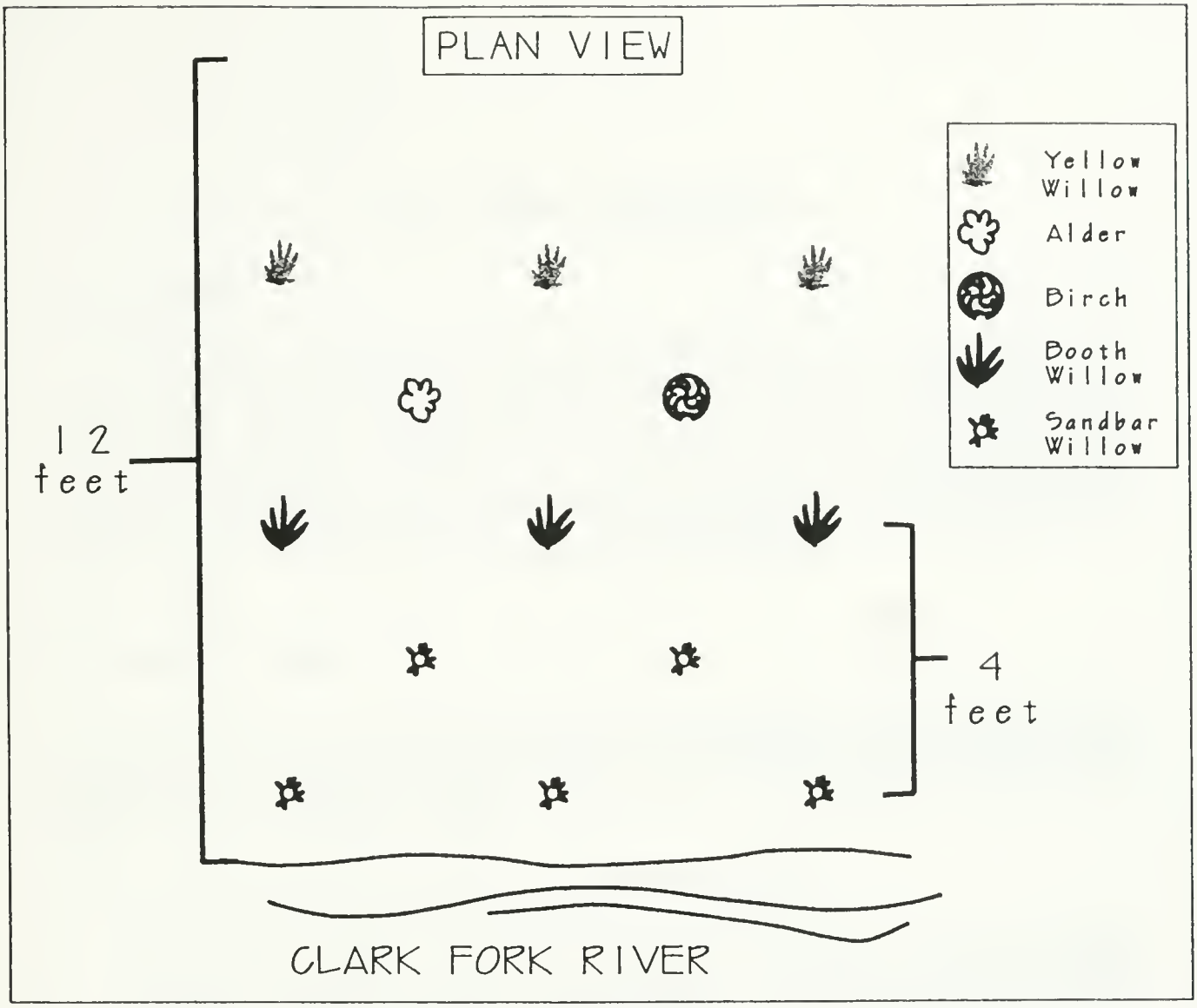
Dry Seedbed Conditions: Inherent with this method of tailings treatment/reclamation is dry soil and seedbed conditions. This was combined with unusually low levels of precipitation, resulting in a seedbed condition that was very dry and powdery, and unsuitable for seeding. Seeding was initiated and completed only after sufficient moisture had been received, which occurred near the beginning of November.

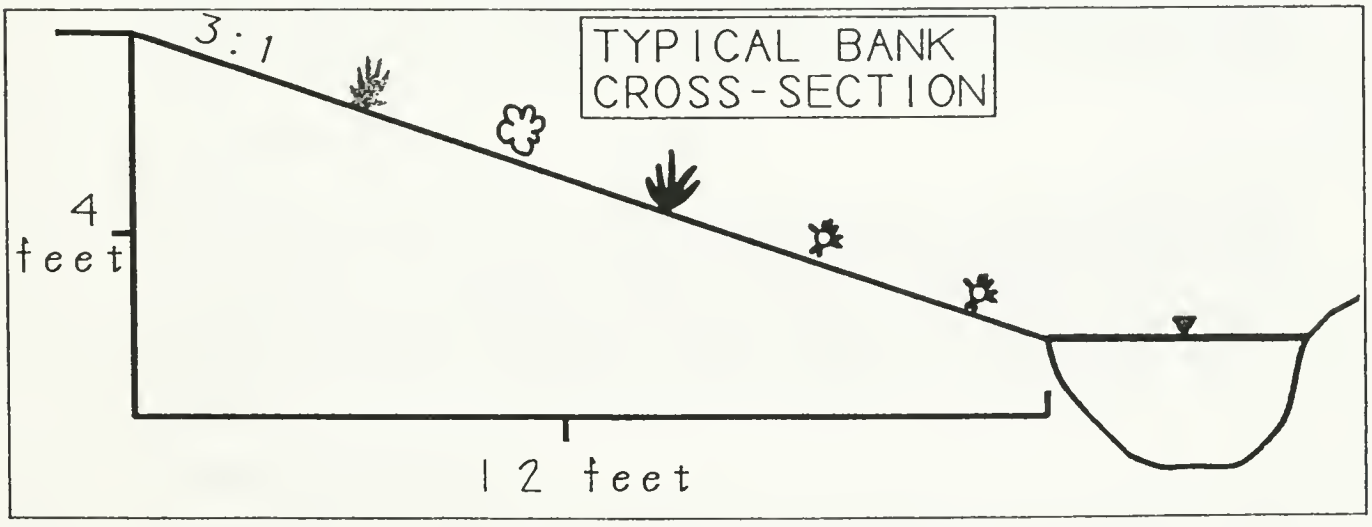
Solutions may include addition of moisture into the soil during, or immediately following liming operations, or irrigation (using sprinkler systems) following seeding.

Work to be Completed: One of the final steps to the restoration of the riparian habitat along the Clark Fork river is the re-establishment of the native trees and shrubs. Woody species will be planted in meander loops to provide protection against soil erosion

during overbank flood events, and to act as natural wind barriers to protect agricultural land and livestock. Other areas to be included in the replanting are the reconstructed streambanks, the newly constructed wetlands, islands/bars, and other selected areas to prevent unwanted vehicle traffic. Establishing woody species benefit a riparian community by providing streambank stabilization, shelter and food for wildlife and livestock, and canopy cover for enhanced fish habitat. The dominant species for this area were identified as sandbar willow; Salix exigua, booth willow; Salix boothii, yellow willow; Salix lutea, bog birch; Betula glandulosa, and thinleaf alder; Alnus incana. The willow species will dominant two thirds of the area that will be replanted, with birch and alder filling in the remaining one third of the total area.

Cuttings from existing plants will be collected in February 1991. The cuttings will be bundled, transported to a cold storage facility and stored until April, at which time the will be returned to the project area and planted. The cuttings will be planted in a diamond pattern along the streambank, at 4 foot intervals, for maximum soil stabilization and protection. See plan view sketch (page 5-10) for details. Additional cuttings will be collected and direct planted at the time the stored cuttings are planted. Test plots will be established, and the cuttings will be monitored on a regular schedule to determine survival rate and performance of each species during the next three years.


PLAN VIEW
Yellow Willow
Alder
Birch
Booth Willow
Sandbar Willow
12 feet
4 feet
CLARK FORK RIVER


TYPICAL BANK CROSS-SECTION
3:1
4 feet
12 feet

6.0 COST SUMMARY

6.1 Budget

The total funding available for the project is $750,000, with the goal to achieve as much reclamation as possible, yet retain the highest standards of professionalism and workmanship. The project budget was set up to allow for over 75% of the overall budget to be used for construction. $600,000 of the budget was to be used for direct project costs (construction, travel and per diem, equipment rental, surveying and laboratory) with the remaining $150,000 allocated for labor. To date, professional fees (labor) total $150,000, and construction and other direct costs approximately $600,000.

6.2 Change Orders

A total of seven change orders were executed during the course of the project, resulting in a total cost increase of $14,822.32. This constitutes a total net increase of less than 2.6% of the construction budget, and less than 2% of the overall project budget. The change orders are summarized below:

Change Orders CO-01B, CO-02, C0-03, C0-04 and CO-05:

Issued July 31, August 13, August 15, August 16, and August 20, 1990, respectively. These change orders, initiated by work directives, were issued in response to field decisions relating to changes in tailings quantities or extent, and related work items, including clearing and grubbing. Localized areas were encountered during construction that required changes in clearing and grubbing, lime, or tillage methods.

Change Order CO-06:

Issued October 11, 1990. This change order was in response to a Contractor request for additional project time of 30 days. Basis for the request was the delay in receiving the U.S. Army Corps of Engineers 404 Permit to allow in-stream channel alterations (permit was applied for in March and received late September). In addition, dry seedbed conditions delayed seeding until sufficient moisture was received.

Change Order CO-07:

Issued October 26, 1990. This change order changed the fencing from F-4 Farm Fence (4 wire) to F-5 Farm Fence (5 wire). Neighboring landowners and Fish,

Wildlife and Parks personnel requested the 5 wire type of fence because of cattle breaching problems associated with a 4 wire fence.

6.3 Construction Costs

The total proposal bid price, as negotiated with and agreed to by Jordan Contracting, Inc., was $571,575.58. To date, the actual construction costs are at $530,204.11. The difference in cost was mainly associated with field decisions changing water requirements, summer mulch, and fencing. Other direct costs bring the total cost to approximately $600,000.

6.4 Professional Fees

Professional fees for the project team (labor) are $150,000.

Table 6.1. Clark fork demonstration project - accrued project cost.

Item Description	PROPOSAL Estimated Quantity	Unit Price	Proposed Total ($)	CHANGE ORDER CO-01B 7/10/90 Quantity	Amount ($)	CO-02 8/13/90 Quantity	Amount ($)	CO-03 8/15/90 Quantity	Amount ($)	CO-04 8/16/90 Quantity	Amount ($)	CO-05 8/20/90 Quantity	Amount ($)
Mobilization	1	34000.00	34000.00		.00		.00		.00		.00		.00
Salv/Repl Topsoil	100	2.25	225.00		.00		.00		.00		.00		.00
Clear and Grub	18	1300.00	23400.00	3.7	4849.00	2.2	2860.00		.00	1.8	2353.00	.3	351.00
Debris Removal	1	3870.00	3870.00		.00		.00		.00		.00		.00
Provide Water	1900	12.00	22800.00		.00		.00		.00		.00		.00
Rip Rap	235	18.50	4347.50		.00		.00		.00		.00		.00
Erosion Contr Mat	4800	3.85	18480.00		.00		.00		.00		.00		.00
Top Dressing	40	.00	.00		.00		.00		.00		.00		.00
Agri Tillage	152	98.00	14896.00	.2	17.64	-.58	-56.84	1.46	143.08	4.06	397.88	-.82	-80.36
Deep Tillage	104	495.00	51480.00	2.7	1346.40	-.34	-168.30	2.24	1108.80	1.9	940.50	.66	326.70
Area Grading	76	150.00	11400.00		.00		.00		.00		.00		.00
Fert and Seed	92	325.00	29900.00		.00		.00		.00		.00		.00
Summer Mulch	76	250.00	19000.00		.00		.00		.00		.00		.00
Vegetative Mulch	92	325.00	29900.00		.00		.00		.00		.00		.00
F-4 Farm Fence	20000	.64	12700.00		.00		.00		.00		.00		.00
Single Panels	30	68.86	2065.80		.00		.00		.00		.00		.00
Double Panels	40	98.48	3939.20		.00		.00		.00		.00		.00
G-2 Gates	160	4.38	700.80		.00		.00		.00		.00		.00
Stock Panels	18	58.46	1052.28		.00		.00		.00		.00		.00
Rome Str - Small	35	75.00	2625.00		.00		.00		.00		.00		.00
Rome Str - Med	18	135.00	2430.00		.00		.00		.00		.00		.00
Rome Str - Large	4	280.00	1120.00		.00		.00		.00		.00		.00
CaO In-Place	866	9.50	8227.00		.00		.00		.00		.00		.00
CaO Stockpile	866	77.00	66682.00		.00		.00		.00		.00		.00
CaCO3 In-Place	6058	9.50	57551.00		.00		.00		.00		.00		.00
CaCO3 Stockpile	6058	23.00	139334.00		.00		.00		.00		.00		.00
Track Excavator	105	90.00	9450.00		.00		.00		.00		.00		.00
D-8 Dozer	0	85.00	.00		.00		.00		.00		.00		.00
12 Yd. Truck	0	50.00	.00		.00		.00		.00		.00		.00
966 Loader	0	65.00	.00		.00		.00		.00		.00		.00
950 Load-Stream	0	75.00	.00		.00		.00		.00		.00		.00
950 Loader	0	65.00	.00		.00		.00		.00		.00		.00
Transport	0	75.00	.00		.00		.00		.00		.00		.00
Project Time	90												
			571575.58		6213.04		2634.86		1251.88		3691.38		597.34

Table 6.1 (Continued).

Item Description	PROPOSAL Estimated Quantity	Change Orders CO-06 Quantity	CO-06 10/11/90 Amount ($)	CO-07 Quantity	CO-07 10/26/90 Amount ($)	Change in Quantity Used	TOTAL Actual Quantity	TOTAL Net Total ($)
Mobilization	1		.00		.00	.0	1.0	34000.00
Salv/Repl Topsoil	100		.00		.00	(100.0)	.0	.00
Clear and Grub	18		.00		.00	8.0	26.0	33813.00
Debris Removal	1		.00		.00	.0	1.0	3870.00
Provide Water	1900		.00		.00	(1501.0)	399.0	4788.00
Rip Rap	235		.00		.00	(235.0)	.0	.00
Erosion Contr Mat	4800		.00		.00	(647.3)	4152.7	15987.89
							.0	
Top Dressing	40		.00		.00	(40.0)	.0	.00
Agri Tillage	152		.00		.00	4.3	156.3	15317.40
Deep Tillage	104		.00		.00	7.2	111.2	55034.10
Area Grading	76		.00		.00	2.2	78.2	11736.00
Fert and Seed	92		.00		.00	(6.9)	85.1	27657.49
Summer Mulch	76		.00		.00	(76.0)	.0	.00
Vegetative Mulch	92		.00		.00	(6.9)	85.1	27657.50
							.0	
F-4 Farm Fence	20000		.00		$ 0.063/ft	(13114.0)	6886.0	4806.42
Single Panels	30		.00		.00	19.0	49.0	3374.14
Double Panels	40		.00		.00	(30.0)	10.0	984.80
G-2 Gates	160		.00		.00	(8.0)	152.0	665.76
Stock Panels	18		.00		.00	(13.0)	5.0	292.30
							.0	
Rome Str - Small	35		.00		.00	(11.0)	24.0	1800.00
Rome Str - Med	18		.00		.00	5.0	23.0	3105.00
Rome Str - Large	4		.00		.00	4.0	8.0	2240.00
					.00		.0	
CaO In-Place	866		.00		.00	56.8	922.8	8766.98
CaO Stockpile	866		.00		.00	56.8	922.8	71058.68
CaCO3 In-Place	6058		.00		.00	(386.6)	5671.4	53878.75
CaCO3 Stockpile	6058		.00		.00	(386.6)	5671.4	130443.29
							.0	
Track Excavator	105		.00		.00	28.9	133.9	12052.80
D-8 Dozer	0		.00		.00	7.5	7.5	637.50
12 Yd. Truck	0		.00		.00	26.8	26.8	1337.50
966 Loader	0		.00		.00	35.2	35.2	2286.05
950 Load-Stream	0		.00		.00	28.2	28.2	2112.00
950 Loader	0		.00		.00	5.5	5.5	357.50
Transport	0		.00		.00	1.9	1.9	143.25
Project Time	90	30				30.0	120.0 Days	
								530204.10

7.0 LANDOWNER MANAGEMENT PLAN

7.1 Management Plan

A major component of insuring successful revegetation of the Clark Fork River floodplain is developing and implementing a grazing management plan. The key objectives of this plan is to establishment quality, self-perpetuating forage for livestock, to improve wildlife and fisheries habitats, establish and maintain a healthy riparian zone, and decrease soil erosion. The grazing management plan was developed cooperatively with each landowner, the Soil Conservation Service and the Department of Fish Wildlife and Parks.

The criteria used to determine a successful revegetation selection was based on selected land use, and grazing schedules. Specific grass varieties were selected for their value in stabilizing soil, providing food and shelter for wildlife and quality forage for livestock. Grass species which performed well on earlier research test plots for metals, saline and drought tolerance were the basis of the seed mix. The project area was drill seeded in the fall of 1990 with a mixture of predominantly wheatgrasses (*Agropyron spp.*), various wildryes (*Elymus spp.*) and a legume (alfalfa, *Medicago sativa*).

The construction of fences to protect newly reseeded areas is another component of the grazing management plan. Riparian corridors along the river were fenced, where allowed by landowners, to protect streambanks from damage by cattle. Other areas were fenced to facilitate grazing rotation. Landowners were consulted prior to fence construction to approve fence lines and specify gate locations. The landowners have the responsibility to maintain the newly constructed fences.

The focus of this management plan is to incorporate grazing methods and techniques specifically designed to improve and sustain the riparian community. Periods of grazing for a given area may vary annually so that grazing during periods of active growth or plant stress does not occur at the same time each year. The grazing management plan determines the season of use and the length of grazing to improve vegetative growth. An example of a grazing schedule for the Clark Fork floodplain is in Appendix C. Each landowner has accepted the responsibility of adhering to the grazing management plan. A monitoring team will be involved in supervising the grazing activity, including recording the length of grazing, forage productivity and species composition in each area during the next three years.

A portion of the reclamation construction was on land managed by the Department of Fish, Wildlife and Parks (FWP). The primary use of this area is providing food and shelter for wildlife. Through our investigation of riparian management, research has shown repeatedly that the plant litter in ungrazed riparian areas does not breakdown, resulting in

a longterm invasion of thistle and noxious weeds. A recommended grazing schedule for this area will allow livestock to graze once every three to five years. This schedule will not interfere with future wildlife use, but will promote increased plant growth and reproduction. Jerry Gallagher, the FWP manager for the Warm Springs district, has agreed to work within this grazing plan as a method for riparian improvement. This grazing will be carefully monitored to insure adequate forage supply for both wildlife and livestock during the grazing period.

8.0 MONITORING PLAN

The effectiveness of the Clark Fork Demonstration project can be determined in part through observation of project construction activities to determine the feasibility of each of the construction techniques. Monitoring and observation of surface water and air during construction also helps identify the short-term impacts of construction. However, long-term project success can only be determined through continued monitoring efforts after completion of the construction phase.

The kind and amount of monitoring information needed is dependent upon the use intended for the information. Ranchers may be able to determine the apparent project success by walking through the site periodically to qualitatively assess the value of the grazing resource. Managers of the fishery resource are likely to require more quantitative data on fish populations, and may be interested in the potential for acute toxicity to result after thunderstorms as in the past. This will require measurements or modeling of runoff from the upland areas of the floodplain. Determination of the suitability of this remedial method for use within the Superfund process will require far more detailed, quantitative information on the long-term effects of remediation on surface water, groundwater, and air resources; and on the permanence of the remedy.

In recognition of the vast differences in the kind and amount of information that may be required from a monitoring program, three alternative monitoring plans were presented to the Council at the January 23, 1991 meeting. These plans were 1) a qualitative low-cost visual monitoring plan that could be adopted by agency staff, 2) a focused quantitative monitoring plan that would measure vegetation success, the chemical and physical characteristics of amended soil, and determine the quality and quantity of runoff from the site, and finally 3) a comprehensive quantitative monitoring plan designed to provide acceptable data under CERCLA RI/FS guidance for a treatability study. The advantages and disadvantages of each monitoring plan are outlined in Table 8-1.

It was agreed by all Council members in attendance that a long-term comprehensive monitoring plan capable of supplying the type of data acceptable under CERCLA RI/FS is needed. Neil Marsh, DHES, agreed to coordinate the efforts in establishing a working group focused on determining the specific goals and issues to address with the monitoring plan. The monitoring plan should be structured so as not to duplicate the monitoring efforts of other study projects of similar nature, such as STARS. A follow-up meeting of members of the monitoring plan work group was held March 18, 1991, and specific monitoring tasks were agreed to and outlined. See Section 8.2.

Table 8.1. Advantages and disadvantages of alternative monitoring plans for the Clark Fork Demonstration project.

MONITORING PLAN	ADVANTAGES	DISADVANTAGES
Visual Monitoring Option	Low cost. No additional funding or contracting required. No written follow-up required.	No quantitative data on project effectiveness collected.
Focused Quantitative Option	Provides quantitative information on project success of importance to fish and wildlife managers, ranchers, and the public. Moderate cost and level of effort. Could be funded from fund interest monies.	Data collected not of adequate type, or quality to allow evaluation of option under CERCLA.
Comprehensive Monitoring	Provides adequate information of acceptable quality to evaluate project as a candidate remedial option under CERCLA.	Highest cost monitoring option. Would require additional source of funding.

8.1 Requirements

A comprehensive monitoring plan for the Clark Fork River Demonstration Project will be developed to collect data that will be sufficient for, and acceptable under, CERCLA RI/FS requirements, and allow the project to be considered as a candidate remedial action under superfund. The kinds of data used to evaluate a remedial action within the RI/FS process are outlined in Table 8.2 (EPA 1988). Much of the data concerning implementability, short-term effectiveness, and cost are currently available and are documented in this report. The initial public response to the project indicates that community acceptance of the proposed remedial measure should be good in that the remedial design has struck a balance between short- and long-term environmental effectiveness and has addressed concerns of numerous resource users including water users, sportsmen, and the agricultural community.

Other data that will be collected in order to identify the compliance with regulatory requirements (ARARS), to predict the long-term effectiveness of the treatment, and to fully describe the reduction in contaminant mobility and overall protection of human health and

the environment. A comprehensive effort will be made to identify long-term stability of the reclaimed project site.

Table 8.2. Data needs for evaluation of a candidate remedial measure under CERCLA RI/FS guidance.

CRITERIA FOR ANALYSIS OF ALTERNATIVE	DESCRIPTION OF SPECIFIC DATA NEED
Overall protection of human health and environment	How does alternative provide for protection of human health and environment?
Compliance with ARAR's	How does alternative comply with contaminant, location, and action-specific ARAR's, and with other criteria or guidance?
Long-term effectiveness	What is the magnitude of residual risk? What is the reliability of the control measure?
Short-term effectiveness	How is the community protected during remedial phase? How are workers protected? What are the environmental impacts? How long until remedial objectives are met?
Reduction of toxicity, mobility, or volume.	What process is used? What volume of waste is treated? What is the expected degree of reduction in toxicity, mobility, or volume?
Implementability	Can the technology be constructed and operated? Can other remedial actions be taken if necessary? Can the effectiveness be monitored? Can approval be obtained from other agencies? Are necessary equipment items and specialists available?
Cost	What are the capital costs? What are the operating and maintenance costs? What is the net present worth cost?
State and Community Acceptance	Only a preliminary assessment of acceptance is required in RI/FS. A complete assessment is provided during the Record of Decision.

8.2 Monitoring Plan

A monitoring plan will be developed which outlines the objectives of the plan, understanding, site characteristics, sampling plan, analytical methods, data management and interpretation, residuals management, and associated health/safety programs.

Specific tasks that will be performed during the sampling portion of the monitoring plan will include vegetation assessment, streambank stability, soil chemistry, surface water evaluation, groundwater and vadose zone investigations. These sampling tasks are briefly explained below:

Vegetation Assessment: Permanent macroplots will be established in each of the treatment methods (deep plow and ag till) for both grazed and ungrazed areas. Additionally, control plots will be established in unreclaimed areas, including grazed and ungrazed areas. These plots will consist of fenced enclosures, and will be representative of existing conditions. Plant performance data including vegetative cover and density will be collected and compared. The effects of grazing will be closely monitored, and compared with the rate/intensity of grazing, and the goals of the grazing management plans. Reference photos will be collected, archived, and compared.

Streambank Stability: Existing and/or historical data (aerial and ground photos, maps) will be collected from SCS, FWP, ARCO, USGS, State and private sources, and compared to recent photos and maps to determine rates and patterns of migration for the river, and streambank stability. A physical inventory survey will be performed on the project reach, and on a control reach immediately downstream from the project area. These surveys will be include photo logs of reclaimed and undisturbed streambanks, and will be compared with earlier surveys completed by SCS. An attempt will be made to determine the migration rates of reclaimed and undisturbed streambanks, and the effects of grazing on streambanks and riparian vegetation. This portion of the study will be in cooperation with the vegetation assessment.

Soil Chemistry: Soil chemical analysis will be used to evaluate the effectiveness of the treatment methods in neutralizing acidity and reducing the mobility of metals in the tailings; and evaluate the degree of amendment-soil mixing achieved during the project. Soil pits will be excavated, and samples collected, with the emphasis on duplicating locations of pre-treatment soil pits. The reclaimed samples will be analyzed for pH, total and soluble metals, and salts (anions and cations). The sample results will be compared with the archived soil samples from pre-treatment soil pits. Further, the effectiveness of mixing will be determined by plotting the results of the analysis versus depth of treatment.

Surface Water Evaluation: This portion of the monitoring plan will be confined to the surface runoff from tailings areas, and the effect on surface water. An actual in-stream surface water investigation will not be included in this monitoring study, but instead will be the responsibility of, and performed by regional surface water groups.

The effect(s) of the surface runoff will be evaluated by two methods: rainfall/infiltration tests using a rainfall simulation; and by gaging small defined watersheds in tailings areas. Four watersheds will be identified, two each in reclaimed and non-reclaimed areas, with grazing included in one of each. Runoff rates will be measured, and samples collected from each watershed. Samples will be analyzed for dissolved metals, total suspended solids, pH, SC and salts. Models will be calibrated to interpret the long-term effects of runoff and erosion.

Groundwater/Vadose Zone Investigation: The objective of this portion of the monitoring plan will be to provide data for modeling both reclaimed and non-reclaimed tailings areas to calculate the probable contaminant loading into the Clark Fork River from leachate produced by precipitation and surface water infiltration, and subsequent percolation through the soil.

The groundwater system in the project area will be defined through a combination of existing data (including existing wells) and a network of installed piezometers. The study will be limited to the shallower aquifer systems (the deeper systems are unlikely to be impacted by surficial tailings). Water samples will be collected and overall site groundwater will be characterized. A control section will be established as a comparison with the project area, and samples will be collected and analyzed for dissolved metals and salts.

The vadose zone will be characterized through installation of neutron probe access tubes, and pressure/suction lysimeters to monitor soil moisture content, and soil water quality, respectively, in the vadose zone. These installations will be in selected locations within the project, and an outside control area.

9.0 SUMMARY AND CONCLUSIONS

9.1 Project Summary

The purpose of the Demonstration Project was to design and construct a project aimed at demonstrating the use of cost-effective, in-place reclamation methods for mine tailings/waste with the floodplain corridor of the upper Clark Fork River. The selected remediation techniques are to achieve a long-term stabilization and neutralization of tailings deposits, with the goal of protecting and supporting a healthy trout fishery; and further, the techniques are expected to be applicable to other portions of the drainage.

The design portion of the project was completed during the winter and spring of 1989 and 1990, by the design team consisting of Schafer and Associates, Spectrum Engineering, and Inter-fluve, Inc. The selected project area encompasses 1.5 stream miles of the Clark Fork River, from the Warm Springs bridge north to the Perkins Land bridge. The design consisted of tailings removal from actively eroding streambank areas and placing those tailings in more stable upland locations away from the river, stabilization of those streambanks, addition and incorporation of chemical amendments (lime), sediment and surface runoff control, revegetation and fencing.

The construction portion of the project was begun in July, 1990 and completed in November of that same year. The construction work was performed by Jordan Contracting, Inc. (Jordan) of Anaconda, Montana. Jordan was selected by a proposal, consisting of the best combination of both cost and technical ability. The construction cost was estimated at $560,297, with an as-built total construction cost of $530,204. Work completed as part of the construction process included:

- Restoration and stabilization of approximately 3200 feet of streambank;
- Modification of the stream channel at 11 locations to reduce the effects of scour on unstable streambanks containing an abundance of tailings;
- Addition of 923 tons of calcium oxide and 5671 tons of calcium carbonate and incorporation into the tailings by deep plowing (56 acres) and agricultural tillage (22 acres);
- Reseeding, fertilizing and mulching of 85 acres of reclaimed land;

- Construction of 24 small, 23 medium and 8 large erosion/sediment control structures;

- Construction of 6886 feet of 5-wire fence and implementation of a grazing management plan.

The project was completed nearly as designed, with only a few minor problems were encountered during the project construction phase. In all cases, field decisions were adequate to remedy the problems, resulting in minor delay to the project schedule.

As part of the project, Landowner Management Plans were developed in cooperation with SCS, the landowners, FWP and Schafer. The key objective of the plan(s) is to develop and maintain quality forage for livestock, improve wildlife and fisheries, establish and maintain a healthy riparian zone, and decrease soil and streambank erosion. The plan defines grazing management for a period of three to five years.

Follow-up work to the Demonstration Project include willow sprigging and monitoring to determine the effectiveness of the treatment methods. The willow sprigging will be completed during the spring of 1991, while the monitoring plan calls for a three year program (1991 - 1994) in which vegetation, streambank stability, soil chemistry, surface water, groundwater, and vadose zone will be carefully monitored to determine whether or not the long-term objectives of the Demonstration Project were met.

9.2 Conclusions

The effectiveness of the selected remedial techniques used on Clark Fork River Demonstration project, and whether those techniques meet the goals and objectives as outlined by the Council, is the key to the project. The goals include both short-term and long-term objectives, of which only a portion of the short-term goals can be answered at this time. Some of the short-term goals which can be answered include public acceptance, cost-effectiveness, feasibility, ability to transfer the selected methods to other portions of the drainage, and short-term impact to surface water and air quality during construction. Data concerning these goals is currently available, and partially documented in this report. Long-term goals can only be determined through continued monitoring efforts after completion of the construction phase.

The initial public response from landowners, special interest groups, sportsmen, FWP, and the general public is favorable in that the remedial methods addressed concerns of all resource users. The costs of the project are documented in this report, as are the feasibility of the selected methods. The reclamation techniques employed during this project are readily transferable to other locations within the drainage, as well as other sites containing mine tailings within the floodplain. Short-term impact to the surface water and air quality during construction was minimal.

Long-term goals include, among others, maintenance or improvement of surface water quality and habitat, and subsequent enhancement of fisheries; neutralization and/or stabilization of tailings deposits; reduction of heavy metals movement into surface and groundwater; and, preservation and enhancement of agricultural uses in the region. These are questions that will be answered with a long-term monitoring program. However, based on results from other studies of similar nature, these types of goals appear to be within reach with this type of remediation effort.

9.3 Suggested Changes

As long-term data is collected, and the results of the monitoring plan compiled, changes in the methods employed may become evident, however, at the present time, no major changes in the reclamation methods are suggested. Minor changes were directed by field supervision during the course of the project, and are outlined in Section 5.8.

10.0 REFERENCES CITED

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APPENDIX A.

PERMITS

DEPARTMENT OF THE ARMY
CORPS OF ENGINEERS, OMAHA DISTRICT
215 NORTH 17TH STREET
OMAHA, NEBRASKA 68102-4978

REPLY TO
ATTENTION OF

September 18, 1990

Regulatory Branch
P.O. Box 5, Omaha, Nebraska 68101-0005

Mr. William Schafer
Schafer and Associates
PO Box 6186
Bozeman, Montana 59715

Dear Mr. Schafer:

Reference is made to the Department of the Army permit issued to you on August 30, 1990, number MT 2SB OXT 2 15733. This pertains to the Clark Fork Demonstration Project north of Warm Springs, Montana.

During construction, the enclosed yellow notice of authorization must be displayed near the project that is authorized by this permit. After construction is complete, please permanently display the metal permit near the authorized activity.

The permit specifies that the authorized work should be completed by August 31, 1993. Please make a note of this on your copy of the permit, at general condition number 1 on page 1.

You are requested to notify this office when the work has been started and also when completed.

Sincerely,

Rosemary C. Hargrave

Rosemary C. Hargrave, M.S.
Acting Chief, Regulatory Branch
Operations Division

Enclosures

WY 2SB OST 2 15638	DEPARTMENT OF COMMERCE	PLACEMENT OF FILL MATERIAL IN THE KEYHOLE RESERVOIR	DA PERMIT ISSUED 9/21/90
CO 2SB OXT 2 14990 C.O.E. 90-05	HABITAT IMPROVEMENT WORK IN THE SOUTH PLATTE RIVER	PLACEMENT OF FILL MATERIAL IN THE SOUTH PLATTE RIVER	AUTHORIZED 9/14/90
CO 2SB OXT 2 09158 AMENDMENT 1	GOLDSMITH METROPOLITAN DIST.	PLACEMENT OF FILL MATERIAL IN GOLDSMITH GULCH	AMENDMENT ISSUED 9/8/90
CO 2SB OXT 2 15461	COLORADO DIVISION OF PARKS & OUTDOOR RECREATION	PLACEMENT OF FILL MATERIAL IN JACKSON LAKE	DA PERMIT ISSUED 9/7/90
MT 2SB OXT 2 15717	BEAVERHEAD NATIONAL FOREST	PLACEMENT OF FILL MATERIAL IN WADE LAKE	DA PERMIT ISSUED 9/4/90
MT 2SB OXT 2 15784	MONTANA DEPARTMENT OF HIGHWAYS	PLACEMENT OF FILL MATERIAL IN EAST FORK ROSEBUD CREEK	DA PERMIT ISSUED 9/6/90
MT 2SB OXT 2 15836	LEE METCALF NATIONAL WILDLIFE REFUGE	PLACEMENT OF FILL MATERIAL IN WETLANDS (RAVALLI POND)	DA PERMIT ISSUED 9/19/90
MT 2SB OXT 3 15839	HOLLY SUGAR CORPORATION	PLACEMENT OF FILL MATERIAL IN THE YELLOWSTONE RIVER	DA PERMIT ISSUED 9/27/90
CO 2SB OXT 2 15876	LARIMER COUNTY	PLACEMENT OF FILL MATERIAL IN THE CACHE LA POUDRE RIVER	DA PERMIT ISSUED 9/26/90

WY 2SB OST 2 15638	DEPARTMENT OF COMMERCE	PLACEMENT OF FILL MATERIAL IN THE KEYHOLE RESERVOIR	DA PERMIT ISSUED 9/21/90
CO 2SB OXT 2 14990 C.O.E. 90-05	HABITAT IMPROVEMENT WORK IN THE SOUTH PLATTE RIVER	PLACEMENT OF FILL MATERIAL IN THE SOUTH PLATTE RIVER	AUTHORIZED 9/14/90
CO 2SB OXT 2 09158 AMENDMENT 1	GOLDSMITH METROPOLITAN DIST.	PLACEMENT OF FILL MATERIAL IN GOLDSMITH GULCH	AMENDMENT ISSUED 9/8/90
CO 2SB OXT 2 15461	COLORADO DIVISION OF PARKS & OUTDOOR RECREATION	PLACEMENT OF FILL MATERIAL IN JACKSON LAKE	DA PERMIT ISSUED 9/7/90
MT 2SB OXT 2 15717	BEAVERHEAD NATIONAL FOREST	PLACEMENT OF FILL MATERIAL IN WADE LAKE	DA PERMIT ISSUED 9/4/90
MT 2SB OXT 2 15784	MONTANA DEPARTMENT OF HIGHWAYS	PLACEMENT OF FILL MATERIAL IN EAST FORK ROSEBUD CREEK	DA PERMIT ISSUED 9/6/90
MT 2SB OXT 2 15836	LEE METCALF NATIONAL WILDLIFE REFUGE	PLACEMENT OF FILL MATERIAL IN WETLANDS (RAVALLI POND)	DA PERMIT ISSUED 9/19/90
MT 2SB OXT 3 15839	HOLLY SUGAR CORPORATION	PLACEMENT OF FILL MATERIAL IN THE YELLOWSTONE RIVER	DA PERMIT ISSUED 9/27/90
CO 2SB OXT 2 15876	LARIMER COUNTY	PLACEMENT OF FILL MATERIAL IN THE CACHE LA POUDRE RIVER	DA PERMIT ISSUED 9/26/90

Montana Department of Fish, Wildlife & Parks

3201 Spurgin Rd.
Missoula,MT 59801
March 13, 1990

John D. Goering, Hydrogeologist
Schafer and Associates
P.O. Box 6186
611 N. Wallace Ave.
Bozeman, MT 59715

SUBJECT: Permit No. MISC-28-90 R-2 Waterbody: Clark Fork

Project Name: CLark Fork Demo Project Water Code: 06-1140

Dear Mr. Goering:

Relative to the Montana Stream Preservation Act, the Department has completed our review of your proposed project on the Clark Fork River. Your project has been approved with the following special conditions:

1. All in-stream work shall be completed in an expeditious manner to avoid unnecessary impacts to the streams;

2. Extra precautions shall be taken to preserve existing riparian vegetation;

3. All construction activities performed in the stream and immediate vicinity, shall be conducted in a manner to reduce in-stream turbidity along with minimizing disturbances to the streambed and/or streambank;

4. All streambank and adjacent areas disturbed by the construction activity shall be protected with temporary erosion control measures during the construction activities. These areas shall be reclaimed with long-term erosion control measures and revegetated immediately after construction;

NOTE: This permit is valid for one year from the date of receipt.

__ This project will cause a significant increase in turbidity, therefore, the Department of Health and Environmental Sciences, Water Quality Bureau, should be contacted for an exemption from the surface water quality standards (3-A Authorization).

_x_ This project will <u>not</u> cause significant turbidity and a 3-A Authorization will not be required.

Sincerely,

Dennis L. Workman

Dennis L. Workman
Fisheries Manager

FWP Use Only
X Form Letter to Applicant
Water Code: 06-1140
Appl. No. Misc-28-90

STREAM PRESERVATION ACT PERMIT APPLICATION

"Notice of Construction"
(Please Print or Type)

Address: *(see reverse side)*

To: MONTANA DEPARTMENT OF FISH, WILDLIFE & PARKS
Region 2, Dennis Workman Attn: Fish Manager
3201 Spurgin Road
Missoula, MT 59801

SPONSORING AGENCY: Schafer and Associates
Address: P.O. Box 6186
611 N. Wallace Ave.
Bozeman, MT 59715

Contact Person: John D. Goering
Title: Hydrogeologist
Telephone: (406) 587-3478
586-9511

Official In Charge: William M. Schafer
Title: Principal/Soil Scientist
Telephone: (406) 587-3478

PROJECT IDENTIFICATION: Project Name: Clark Fork River Demonstration Project
Project No. _____ Waterbody: Clark Fork River

Location: Township 5N Range 9W Section 5,7,18 County: Deer Lodge
Location to Nearest Town: Extends northward from a point 0.5 miles E. of Warm Springs, MT

Project Features:

___ Bridge	___ Culvert	___ Other
___ Work Bridge and Removal	___ Dredging	
	___ Hydraulic Structure	
___ Bridge Demolition	X Channel Change	
___ Core Drill	X Bank Stabilization	

Project Scheduling: Contract Letting 5 / 14 / 90 (May be several contracts)
Construction Period 6 / 01 / 90 to 10 / 31 / 90

Allow sixty (60) days for application processing. A set of preliminary plans or sketches of the proposed project must accompany this application. (NOTE: Dept. of Hwy. sponsored projects require two sets of plans sent with this form to Helena FWP address.)

X Plans X Sketches X Other Conceptual plan, location, and ownership maps, typical construction plan

John D. Goering
Signature

January 23, 1990
Date

Distribution: White/Yellow – Region Pink – Applicant
Form: 124SPA 5/89

Form 270 Rv82

STATE OF MONTANA

NATURAL STREAMBED AND LAND PRESERVATION ACT
NOTICE OF PROPOSED PROJECT

App. No._____

Date Rec'd_____

NOTE: SEE REVERSE SIDE FOR ADDITIONAL INFORMATION REQUIRED

1. a. Name of Applicant Schafer and Associates
Address P.O. Box 6186 City or Town Bozeman
State Montana Zip Code 59715 Telephone No. (406) 587-3478

b. Name and address of owner of site: (if different from applicant)
Hans Lambert Telephone No. (406) 693-2396
12204 East Side Road, Warm Springs, MT 59756

c. Name, address and title of applicant's authorized agent for permit application coordination: (attorney, business manager, etc.)
John D. Goering, Senior Hydrogeologist Telephone No. (406) 587-3478
P.O. LBox 6186, 611 N. Wallace Ave.
Bozeman, MT 59715

2. Name of stream at location of activity: Clark Fork River County: Deer Lodge
Location of the proposed activity: SW ¼ NW ¼ ¼ Section 5 Township 5N Range 9W

3. Describe proposed activity, type of structure, method of construction, materials and equipment to be used:
Demonstrate reclamation/rehabilitation techniques that substantially improve Clark Fork River fishery habitat and water quality and that improves forage production on contaminated flood plain materials. No channel modifications will be made during this project (see attached engineering drawings).

4. Date activity is proposed to commence: ASAP Date activity is expected to be completed: 10/31/90

5. Names and addresses of surrounding property owners and those whose lands adjoin the stream near the point of activity: (upstream, downstream, across)
Ownership map attached

6. Has any agency denied approval for the activity described herein or for any activity related to the activity described herein? ___Yes ✓No If yes, explain further on separate sheet.

7. THE APPLICANT CERTIFIES THAT THE STATEMENTS APPEARING HEREIN ARE TO THE BEST OF HIS KNOWLEDGE TRUE AND CORRECT, AND HEREBY AUTHORIZES THE INSPECTION OF THE PROJECT SITE BY INSPECTING AUTHORITIES.

Signature: John D. Goering Date: Feb 9, 1990

RETURN COMPLETED FORM TO YOUR LOCAL CONSERVATION DISTRICT OFFICE

Form 271 Rv82

THE FOLLOWING ITEMS ARE TO BE COMPLETED BY THE CONSERVATION DISTRICT BOARD

The application proposal (is) (is not) a project as defined by the Natural Streambed and Land Preservation Act.

Reasons: _____

If the application is not a project as defined in this act, applicant may proceed with proposal.

CONSERVATION DISTRICT BOARD SIGNATURES:

_____

_____

_____ Date:_____

_____

_____

Date this determination forwarded to applicant and to the Montana Department of Fish,Wildlife, and Parks: _____

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES

STAN STEPHENS, GOVERNOR

COGSWELL BUILDING

STATE OF MONTANA

FAX # (406) 444-2606

HELENA, MONTANA 59620

March 1, 1990

Schafer & Associates
P.O. Box 6186
Bozeman, MT 59715

RE: Authorization No. MT-18-90 Short-Term Exemption from Surface Water Quality Turbidity Standards VALID June 1, 1990 through October 31, 1990

Dear Mr. Goering:

We have completed our review of your application for activity on the Clark Fork River - CFRDP. This activity is herewith exempt from the applicable Montana surface water quality turbidity standards if it is carried out in accordance with the following conditions:

(1) Construction activities in or near the watercourse are to be limited to the minimum area necessary, and conducted so as to minimize increases in suspended solids and turbidity which may degrade water quality and damage aquatic life outside the immediate area of operation,

(2) The use of machinery in the watercourse shall be avoided unless absolutely necessary. To prevent leaks of petroleum products into waterways, no defective equipment shall be operated in the watercourse or adjacent areas capable of contributing surface flow to the watercourse,

(3) Precautions shall be taken to prevent spillage of any petroleum products, chemicals or other deleterious material in or near the watercourse, and no equipment shall be fueled or serviced in adjacent areas capable of contributing surface flow to the watercourse,

(4) All disturbed areas on the streambank and adjacent areas created by the construction activity shall be protected with temporary erosion control during construction activities. These areas shall be reclaimed with appropriate erosion control measures and revegetated to provide long-term erosion control,

(5) Any excess material generated from this project must be disposed of above the ordinary high water mark, not classified as a wetland, and in a position not to cause pollution to State waters,

(6) Clearing of vegetation will be limited to that which is absolutely necessary for construction of the project,

(7) The use of asphalt or petroleum-based products as riprap is strictly prohibited. Its use as fill material is also prohibited if it is placed in a location where it is likely to cause pollution of State waters,

(8) This authorization does not authorize a point source surface water discharge. A MPDES permit is required for said discharge, and

(9) The applicant must conduct all activities in full and complete compliance with all terms and conditions of any permit for this activity issued pursuant to the Montana Natural Streambed and Land Preservation Act (310 permit) or the Montana Stream Protection Act (124 permit), and any valid Memorandum of Agreement and Authorization (MAA) negotiated for this activity.

This exemption is valid for the period June 1, 1990 through October 31, 1990, only. No exemption is valid for more than a one-year period of time.

Any violations of the conditions of this authorization may be subject to an enforcement action pursuant to the applicable provisions of the Montana Water Quality Act.

This authorization is granted pursuant to ARM 16.20.633(3) and only applies to the activity described by your application. Any modification of the activity described in your application which may result in additional turbidity in the stream must receive prior approval from the Department. You may contact me at (406) 444-2406.

Sincerely,

Jack G. Thomas
Environmental Specialist
Water Quality Bureau
Environmental Sciences Division

JGT:pb

APPLICATION FOR SHORT-TERM EXEMPTION
FROM SURFACE WATER QUALITY STANDARDS FOR CONSTRUCTION ACTIVITY
—— ARM 16.20.633 (3) ——

RETURN TO: Water Quality Bureau
Montana Department of Health
and Environmental Sciences
A-206 Cogswell Building
Helena MT 59620

PLEASE PRINT OR TYPE

1. Name, address and telephone number of person responsible for the construction activity.

Name WILLIAM M. SCHAFER

Mailing Address SCHAFER AND ASSOCIATES, P.O. Box 6186

Bozeman, Montana 59715
city state zip code

Telephone number (406) 587-3478
area code

2. Name, address and telephone number of contractor or person doing work. (If unknown or same as above, please note.)

Name INTERFLUVE, INC.

Mailing Address 211 North Grand Ave.

Bozeman, Montana 59715
city state zip code

Telephone number (406) 586-6926
area code

3. General description of the nature of the project. Include name of stream(s) involved.

This project will rehabilitate approximately 1.5 miles of the Clark Fork River in Section 5, 6, 7 and 18, T5N, R9W to improve fish and wildlife habitat and to increase forage production/vegetation cover on contaminated floodplain materials. Tailings will be removed from areas immediately adjacent (30 to 50 ft) to the active channel, banks recontoured and stabilized with riparian vegetation. Natural levees will be enhanced to channel local run-off away from the river into abandoned meanders. Floodplain tailings, along with tailings removed from bank areas, will be amended, mixed, deep plowed and revegetated. Limited channel work will be made to reduce erosion in critical areas.

4. Detailed description of all construction activities that may result in stream sedimentation and/or turbidity (e.g., riprapping, instream work with heavy equipment, dredging, channeling and excavations).

Tailings removal and stream bank recontouring will likely produce limited sedimentation and/or turbidity. No equipment will be operated instream for this work. The limited instream channel modifications will produce sedimentation and turbidity. Most of this work will be done with excavators operating outside the channel. These modifications are being designed to closely mimic natural fluvial process to produce a stable channel. The exact locations of all these proposed changes are not yet known, but one identified location is in the W1/2, Sec 7 where the river course has been affected by the abandoned railroad grade. No instream rip-rap will be used on this project.

5. List type of equipment to be used to accomplish the work described in No. 4 above. Discuss how the equipment will be used in conjunction with the project.

Track type excavator (backhoe) will be utilized to remove tailings from bank areas. Bank recontouring will likely utilize the same unit, along with dozers and possibly scrapers. Floodplain amendments will be applied with standard agricultural implements and a deep (48") plow.

6. Anticipated date for construction activity to commence.

June 1, 1990

7. Estimated completion date. October 31, 1990

8. Discuss alternatives considered and/or available for minimizing or eliminating stream sedimentation due to this project.

All options considered (tailings removal, solidification, isolation, neutralization) will cause similar or more extensive sedimentation. Wetlands were not considered due to the extensive size that would be needed for treatment of the entire Clark Fork River flow. The no-action alternative would likely produce less short term, but more long term sedimentation and not improve fish and wildlife habitat or forage production.

9. Name of the county at the construction site.

Deer Lodge

10. General information. Provide a location map of the construction activity. Photographs of the construction site would be beneficial (if available).

Engineering plans enclosed for Clark Fork River RIT Demonstration Project. Other enclosed material: Landownership map; Clark Fork River Demonstration Project Conceptual Plan (applicable to both Clark Fork River Projects); Environmental Assessment (for entire reach of the Clark Fork in Sections 5, 6, 7 and 18, T5N, R9W).

Prepared by John D. Leitzinger
signature

HYDROGEOLOGIST - PERMIT COORDINATOR
title

Date FEB 16, 1990

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES

STAN STEPHENS, GOVERNOR

COGSWELL BUILDING

STATE OF MONTANA

FAX # (406) 444-2606

HELENA, MONTANA 59620

444-2406

August 7, 1990

Mr. Dale E. Miller
Inter-Fluve, Inc.
211 North Grand
Bozeman, MT 59715

RE: Authorization No. MT-99-90 Short-Term Exemption from Surface Water Quality Turbidity Standards VALID August 8, 1990 through October, 15, 1990

Dear Mr. Miller:

We have completed our review of your application for activity on the Clark Fork River. This activity is herewith exempt from the applicable Montana surface water quality turbidity standards if it is carried out in accordance with the following conditions:

(1) Construction activities in or near the watercourse are to be limited to the minimum area necessary, and conducted so as to minimize increases in suspended solids and turbidity which may degrade water quality and damage aquatic life outside the immediate area of operation,

(2) The use of machinery in the watercourse shall be avoided unless absolutely necessary. To prevent leaks of petroleum products into waterways, no defective equipment shall be operated in the watercourse or adjacent areas capable of contributing surface flow to the watercourse,

(3) Precautions shall be taken to prevent spillage of any petroleum products, chemicals or other deleterious material in or near the watercourse, and no equipment shall be fueled or serviced in adjacent areas capable of contributing surface flow to the watercourse,

(4) All disturbed areas on the streambank and adjacent areas created by the construction activity shall be protected with temporary erosion control during construction activities. These areas shall be reclaimed with appropriate erosion control measures and revegetated to provide long-term erosion control,

(5) Any excess material generated from this project must be disposed of above the ordinary high water mark, not classified as a wetland, and in a position not to cause pollution to State waters,

(6) Clearing of vegetation will be limited to that which is absolutely necessary for construction of the project,

(7) The use of asphalt or petroleum-based products as riprap is strictly prohibited. Its use as fill material is also prohibited if it is placed in a location where it is likely to cause pollution of State waters,

(8) This authorization does not authorize a point source surface water discharge. A MPDES permit is required for said discharge, and

(9) The applicant must conduct all activities in full and complete compliance with all terms and conditions of any permit for this activity issued pursuant to the Montana Natural Streambed and Land Preservation Act (310 permit) or the Montana Stream Protection Act (124 permit), and any valid Memorandum of Agreement and Authorization (MAA) negotiated for this activity.

This exemption is valid for the period August 8, 1990 through October 15, 1990, only. No exemption is valid for more than a one-year period of time.

Any violations of the conditions of this authorization may be subject to an enforcement action pursuant to the applicable provisions of the Montana Water Quality Act.

This authorization is granted pursuant to ARM 16.20.633(3) and only applies to the activity described by your application. Any modification of the activity described in your application which may result in additional turbidity in the stream must receive prior approval from the Department. You may contact me at (406) 444-2406.

Sincerely,

Jack G. Thomas
Environmental Specialist
Water Quality Bureau
Environmental Sciences Division

JGT:pb

Montana Department of Fish, Wildlife & Parks

August 6, 1990

Mr. Dale Miller
Inter-Fluve, Inc.
211 North Grand
Bozeman, MT 59715

SUBJECT: Permit No. MISC-58-90 R-2 Waterbody: Clark Fork River
Project Name: CFR Demonstration Project Water Code: 06-1121

Dear Dale:

Relative to the Montana Stream Preservation Act, the Department has completed our review of your proposed project in conjunction with the Clark Fork Demonstration Project. Your project has been approved with the following special conditions:

1. All in-stream work shall be completed in an expeditious manner to avoid unnecessary impacts to the streams;

2. Extra precautions shall be taken to preserve existing riparian vegetation;

3. All construction activities performed in the stream and immediate vicinity, shall be conducted in a manner to reduce in-stream turbidity along with minimizing disturbances to the streambed and/or streambank;

4. All streambank and adjacent areas disturbed by the construction activity shall be protected with temporary erosion control measures during the construction activities. These areas shall be reclaimed with long-term erosion control measures and revegetated immediately after construction;

NOTE: This permit is valid for one year from the date of receipt.

_x_ This project will cause a significant increase in turbidity, therefore, the Department of Health and Environmental Sciences, Water Quality Bureau, should be contacted for an exemption from the surface water quality standards (3-A Authorization).

___ This project will <u>not</u> cause significant turbidity and a 3-A Authorization will not be required.

Sincerely,

Dennis Workman
Fisheries Manager

c: Ken Chrest
Jack Thomas, Water Quality Bureau

MONTANA DEPARTMENT OF FISH, WILDLIFE & PARKS
1420 East Sixth Avenue Helena, MT 59620
(406) 444-2449

ENVIRONMENTAL ASSESSMENT

Division/Bureau FISHERIES

Project or Application Clark Fork demonstration reclamation project

Description of Project Funds provided to the Governor's office by ARCO Coal Company will be used to reclaim streamside tailings along the Clark Fork River between Warm Springs Bridge and Perkins Lane Bridge. Reclamation methods will include: amending metals contaminated soils with lime to increase their pH and reduce metals mobility, removing contaminated soils that encroach on the streambank; stabilization and re-vegetation of the streambank with a biodegradable fabric and willows, revegetation of amended soils by seeding with appropriate plant species.

POTENTIAL IMPACT ON PHYSICAL ENVIRONMENT

	Major	Moderate	Minor	None	Unknown	Comments on Attached Pages
1. Terrestrial & aquatic life and habitats		X				X
2. Water quality, quantity and distribution		X				X
3. Geology & soil quality, stability and moisture		X				X
4. Vegetation cover, quantity and quality		X				X
5. Aesthetics		X				X
6. Air quality			X			X
7. Unique, endangered, fragile, or limited environmental resources				X		
8. Demands on environmental resources of land, water, air and energy				X		
9. Historical and archaeological sites				X		

Potential Impacts on Physical Environment

In the reclaimed area, this project will reduce the quantities of metals that enter the Clark Fork during thunderstorms and spring runoff. These improvements should result in improved water quality, soil quality and stability, quantity and quality of vegetative cover, aesthetics, quality of recreational opportunity. These improvements will be enhanced when upstream reclamation is completed under Superfund. Particularly, removal of tailings from the Mill-Willow bypass.

There may be localized decreases in air quality associated with liming and tillage of tailings areas.

POTENTIAL IMPACTS ON HUMAN ENVIRONMENT

	Major	Moderate	Minor	None	Unknown	Comments on Attached Pages
1. Social structures and mores				X		
2. Cultural uniqueness and diversity				X		
3. Local and state tax base and tax revenue				X		
4. Agricultural or industrial production				X		
5. Human health				X		
6. Quantity and distribution of community and personal income				X		
7. Access to and quality of recreational and wilderness activities		X				X
8. Quantity and distribution of employment				X		
9. Distribution & density of population & housing				X		
10. Demands for government services				x		
11. Industrial and commercial activity				x		
12. Demands for energy				X		
13. Locally adopted environmental plans and goals				X		
14. Transportation networks and traffic flows				X		

Other groups or agencies contacted or which may have overlapping jurisdiction _____

_____

Individuals or groups contributing to this EA _____

_____

Recommendation concerning preparation of EIS Not necessary

_____

PER prepared by Glenn Phillips

Date _____

RECEIVED APR 1 6 1990

DEPARTMENT OF
HEALTH AND ENVIRONMENTAL SCIENCES

AIR QUALITY BUREAU

STAN STEPHENS, GOVERNOR

COGSWELL BUILDING

STATE OF MONTANA

FAX # (406) 444-2606

HELENA, MONTANA 59620

(406) 444-3454

April 12, 1990

John D. Goering
Senior Hydrogeologist/Permit Coordinator
Schafer & Associates
P. O. Box 6186
Bozeman, MT 59715

Dear Mr. Goering:

The Montana Air Quality Bureau has reviewed your proposal for the CFRRIT and agrees with your assessment that an air quality permit or open burning permit is not required. You must, however, comply with the requirements of ARM 16.8.1401 and minimize fugitive dust. The methods you have outlined in your proposal for this appear adequate.

It would appear, however, that a major open burning permit would be required for the CFRDP. Please determine, as accurately as possible, the total acres cleared in the CFRDP. If there will be more than one hundred acres cleared, a major open burning permit will be required. I am enclosing a permit application for your use should that be the case.

Sincerely,

Charles Homer
Environmental Specialist

CH:kmj

Enclosure

MAJOR OPEN BURNER PERMIT APPLICATION

Applicable only for large open burners in excess of 2,000 acres of grass or cropland, or 100 acres of forest slash per year.

Name of Applicant: _____

Mailing Address: _____

Telephone Number: _____

Type of Material to be Burned: _____

_____

Quantity (Total Acreage) to be Burned Per Year: _____

Number of Burns Per Year Required: _____

Location (Sec., Township & Range or Map), Elevation, Acreage, Average Fuel Loading, and Burn Type of Each Burn _____

_____

_____

_____

_____

_____

_____

_____

_____

Authorized Signature _____ Date _____

MAIL TO: Air Quality Bureau
Dept. of Health & Env. Sciences
Cogswell Building
Helena, MT 59620

Phone: (406) 444-3454

February 14,1990

Mr. John Hamill
Floodplain Management Section
Engineering Bureau
Montana Department of Natural Resources and Conservation
1520 E. 6TH Avenue
Helena, MT 59620

Dear Mr. Hamill,

Enclosed are the engineering plans for our Clark Fork River RIT Demonstration Project (CFRRIT). This project has been funded by the Headwaters Resource Conservation and Development Project and covers about 1000 feet of the river in SW1/4,NW1/4, Sec.5, T5N,R9W. This project represents an initial pilot scale study for rehabilitating the Clark Fork River and will be followed very closely by the larger (1.5 mile) Montana Governors Office funded project using similar methods.

As the plans indicate, limited use will be made of low berms, set about 30 to 50 feet away from the active channel with tailings removed from the area in between. The purpose of these berms (and keyed rip-rap at these locations) is not to channelize the river but rather to:

- Enhance the natural levee effect diverting local runoff (high in dissolved metals and sediment) away from the active channel and into abandoned meanders, and

- To reduce the potential for erosion of inplace amended tailings deposits during high flow events.

The area between the active channel and the berms will be revegetated with riparian vegetation (willows) which will be both transplanted as mature plants and sprigged. During flood events, the berms will likely be totally submerged, but the reestablished riparian vegetation should reduce flow velocities and hence, the erosion potential in these areas. The keyed rip-rap will be composed of nominal 14 inch material and will be transported as bed load when the river eventually erodes this material through meander migration.

A number of permits have, or are being applied for: (404, 310, 3A, and 124). To date, only the 310 permits have been approved (for both projects) and there is a legal question as to whether these permits are applicable to this project. The engineering plans for the Governor's Office funded project are not yet complete and will be forwarded as soon as they are available. Both of these projects are to be completed during the summer of 1990. A copy of this letter and set of plans is also being sent to Mr. Milo Manning of the Anaconda-Deer Lodge Planning Board for his review. If I can be of further assistance in this matter, please call.

Sincerely,

John D. Goering Senior Hydrogeologist-Permit Coordinator

APPENDIX B.

AS-BUILT DRAWINGS

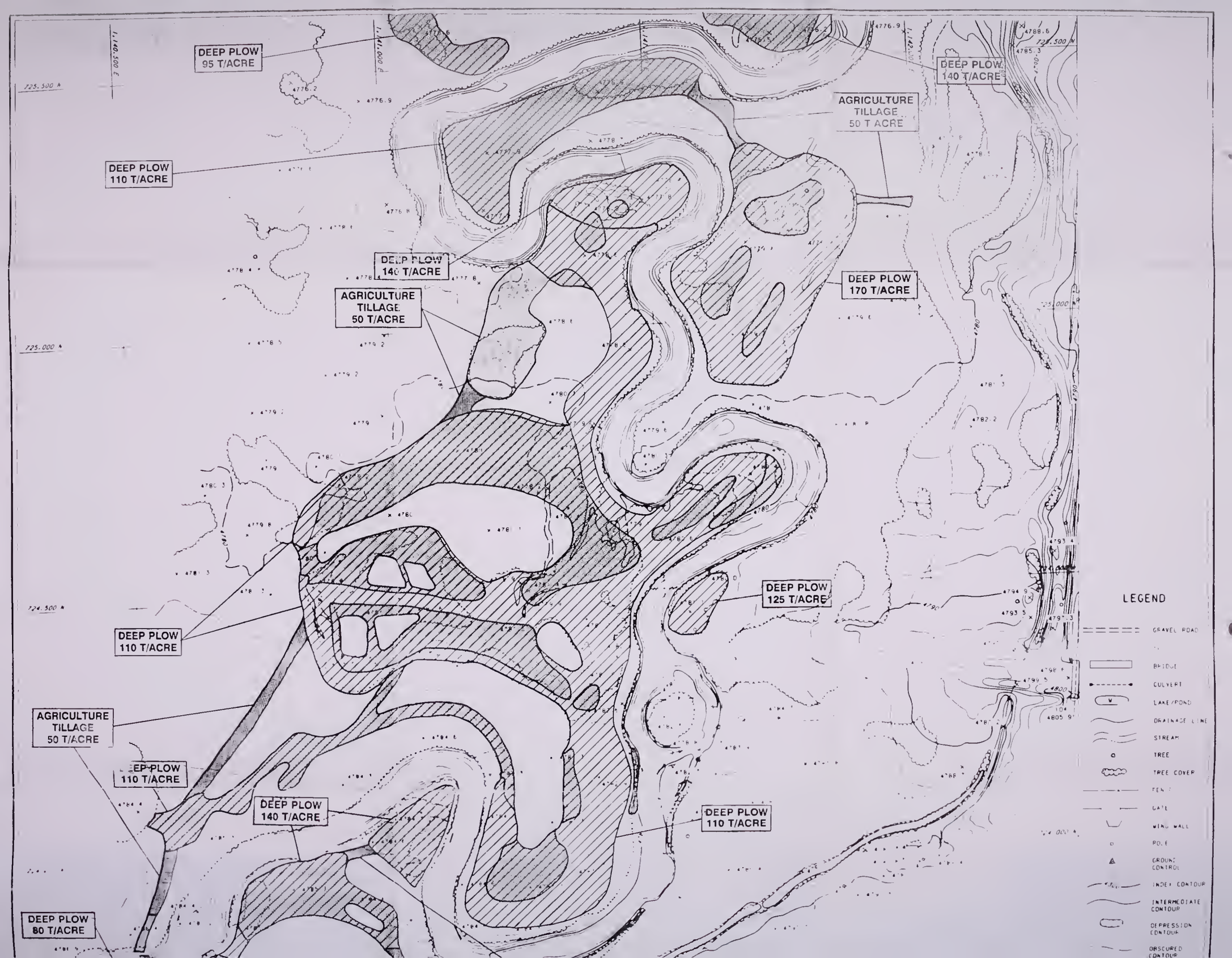
Acres 17.6 Acres
Tons 2,147 Tons

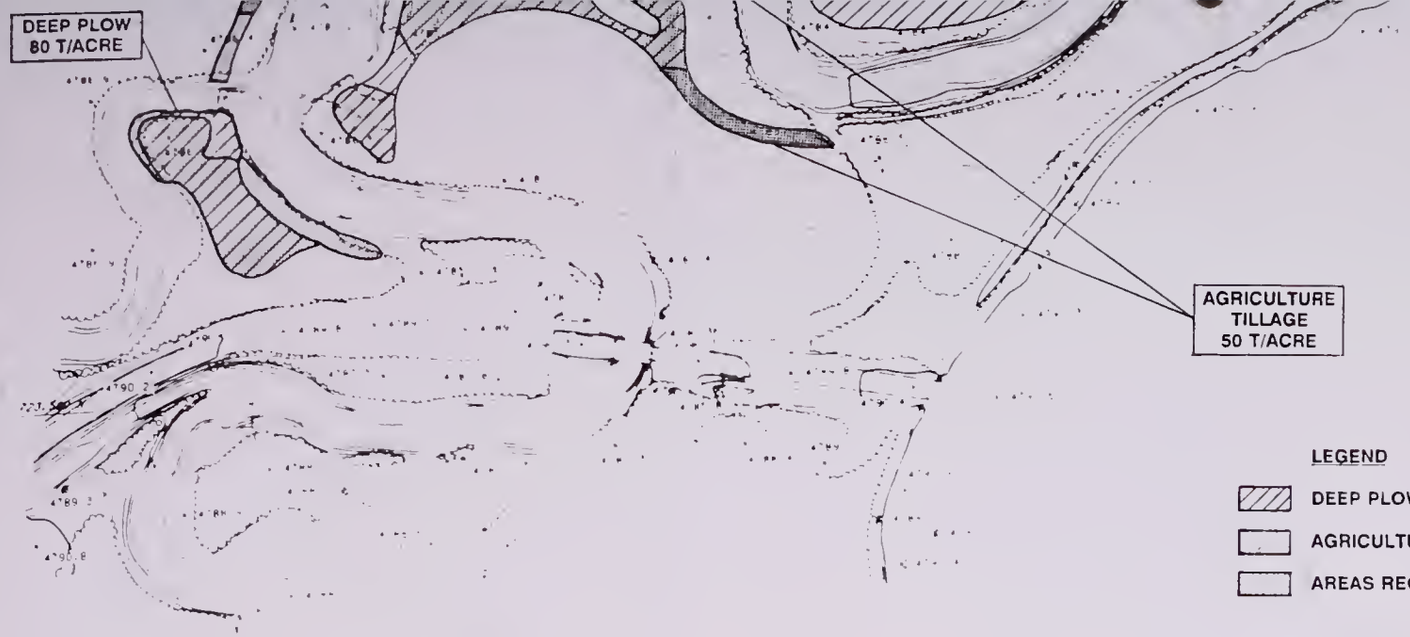
Schafer and Associates
P. O. Box 6186
Bozeman, MT 59715
(406) 586-3481

CLARK FORK DEMO PROJECT

TOPOGRAPHIC MAP

CLIENT	
LOCATION	
SHEET	1 OF 4
DRAWING NUMBER	
REVISION NUMBER:	
DATE:	
SCALE:	1" = 2,000'
DRAWN BY:	
CHECKED BY	


DEEP PLOW
95 T/ACRE
DEEP PLOW
140 T/ACRE
AGRICULTURE
TILLAGE
50 T ACRE
DEEP PLOW
110 T/ACRE
DEEP PLOW
140 T/ACRE
AGRICULTURE
TILLAGE
50 T/ACRE
DEEP PLOW
170 T/ACRE
DEEP PLOW
125 T/ACRE
DEEP PLOW
110 T/ACRE
AGRICULTURE
TILLAGE
50 T/ACRE
DEEP PLOW
110 T/ACRE
DEEP PLOW
140 T/ACRE
DEEP PLOW
110 T/ACRE
DEEP PLOW
80 T/ACRE
LEGEND
GRAVEL ROAD
BRIDGE
CULVERT
LAKE/POND
DRAINAGE LINE
STREAM
TREE
TREE COVER
FENCE
GATE
WING WALL
POLE
GROUND CONTROL
INDEX CONTOUR
INTERMEDIATE CONTOUR
DEPRESSION CONTOUR
OBSCURED CONTOUR



DEPRESSION CONTOUR

OBSCURED CONTOUR

SPOT ELEVATION

Sheets rotated 0.3° from North

LEGEND

- DEEP PLOW
- AGRICULTURE TILLAGE
- AREAS REQUIRING CLEARING AND GRUBBING

LIME APPLICATION/INCORPORATION CHART

Tailings Depth (in)	Total Lime Rate T/AC	Lime Incorp (Tillage) Method	No. of Tillage Passes	Lime Application Lrts T/AC	Retained for Ag Tillage T/AC
0 4	8	None	0	8	0
4 14	50	Ag	2	50	0
14	[illegible]	Deep Plow	2	40	25
16	8	Deep Plow	2	55	25
18	95	Deep Plow	2	70	25
20	110	Deep Plow	2	45,40	25
22	125	Deep Plow	2	50,45	30
24	140	Deep Plow	2	55,50	35
[illegible]	155	Deep Plow	2	60,55	40
28	170	Deep Plow	2	65,60	45
30	170	Deep Plow	2	65,60	45

SHEET 1 SUMMARY

Agricultural Tillage	Deep Plow One Lime Lift	Deep Plow Two Lime Lifts	Dressing [illegible]	Subtotal
2.1 Acres	0.8 Acres	14.7 Acres	Acres	17.6 Acres
105 Tons	70 Tons	1,972 Tons	Tons	2,147 Tons

WARM SPRINGS AREA
Montana

Scale [illegible]

[illegible]

Shafer and Associates
[illegible]

CLARK
FORK
DEMO
PROJECT

TOPOGRAPHIC
MAP

CLIENT	
LOCATION	
SHEET 1 OF 4	
DRAWING NUMBER	
REVISION NUMBER	
DATE	
SCALE	
DRAWN BY	
CHECKED BY	

1,140,500 E
1,141,000 E
1,141,500 E
1,142,000 E

DEEP PLOW
65 T/ACRE

AGRICULTURE
TILLAGE
50 T/ACRE

DEEP PLOW
80 T/ACRE

DEEP PLOW
95 T/ACRE

DEEP PLOW
95 T/ACRE

DEEP PLOW
125 T/ACRE

AGRICULTURE
TILLAGE
50 T/ACRE

DEEP PLOW
80 T/ACRE

DEEP PLOW
110 T/ACRE

DEEP PLOW
80 T/ACRE

AGRICULTURE
TILLAGE
50 T/ACRE

728.000 N

727.500 N

727.000 N

3 000 E

1 143 000 E

LEGEND

- GRAVEL ROAD
- TRAIL
- BRIDGE
- CULVERT
- LAKE/POND
- DRAINAGE LINE
- STREAM
- TREE
- TREE COVER
- FENCE
- GATE
- WING WALL
- POLE
- GROUND CONTROL
- 4300 INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSION CONTOUR
- OBSCURED CONTOUR

SHEET 2 SUMMARY

Agricultural Tillage	Deep Plow One Lime Lift	Deep Plow Two Lime Lifts	Top Dressing (Estimated)	Subtotal
9.9 Acres	6.1 Acres	12.5 Acres	0.0 Acres	28.5 Acres
495 Tons	488 Tons	1,481 Tons	0.0 Tons	2,462 Tons

LEGEND

- DEEP PLOW
- AGRICULTURE TILLAGE
- AREAS REQUIRING CLEARING AND GRUBBING

DEPRESSION CONTOUR

OBSCURED CONTOUR

× 1739.6 SPOT ELEVATION

Sheets rotated 2-31° from North

WARM SPRINGS AREA
Montana

Scale: 1" = 100'

Contour Interval = 2'

Date of Photography: 10-20-87

Compiled By:
HORIZONS, INC.
Rapid City,
South Dakota

Schafer

Schafer and Associates
P O Box 6188
Bozeman MT 59715
(406) 587-3478

CLARK FORK DEMO PROJECT

TOPOGRAPHIC MAP

CLIENT:	
LOCATION:	
SHEET 2 OF 4	
DRAWING NUMBER:	
REVISION NUMBER:	
DATE:	
SCALE:	
DRAWN BY:	
CHECKED BY:	

DEEP PLOW
95 T/ACRE

AGRICULTURE
TILLAGE
50 T/ACRE

AGRICULTURE
TILLAGE
50 T/ACRE

DEEP PLOW
65 T/ACRE

AGRICULTURE
TILLAGE
50 T/ACRE

731,000 N

730,500 N

730,000 N

731,000 E

LEGEND

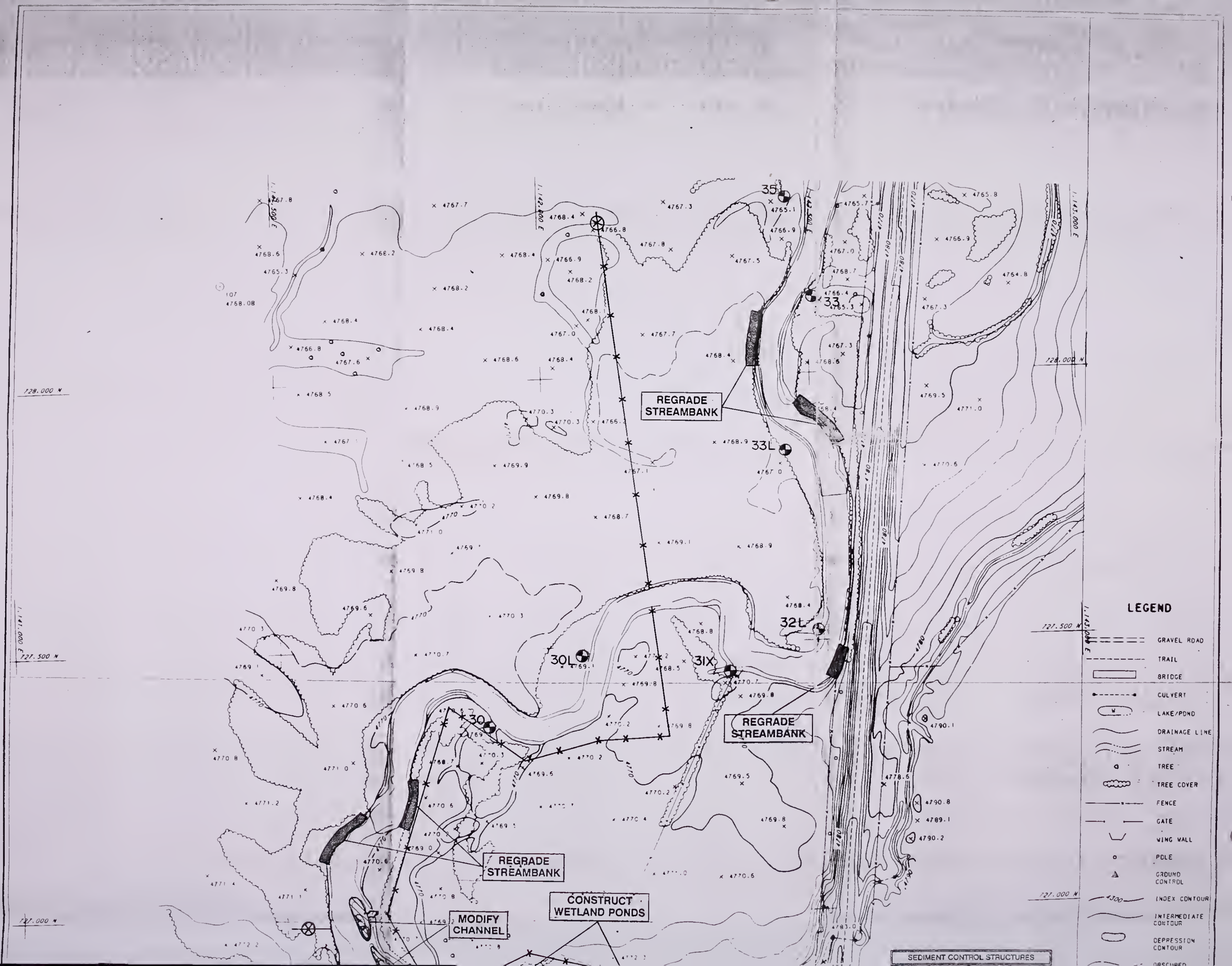
- GRAVEL ROAD
- TRAIL
- BRIDGE
- CULVERT
- LAKE/POND
- DRAINAGE LINE
- STREAM
- TREE
- TREE COVER
- FENCE
- GATE
- WING WALL
- POLE
- GROUND CONTROL
- INDEX CONTOUR
- INTERMEDIATE CONTOUR
- DEPRESSION CONTOUR
- OBSCURED

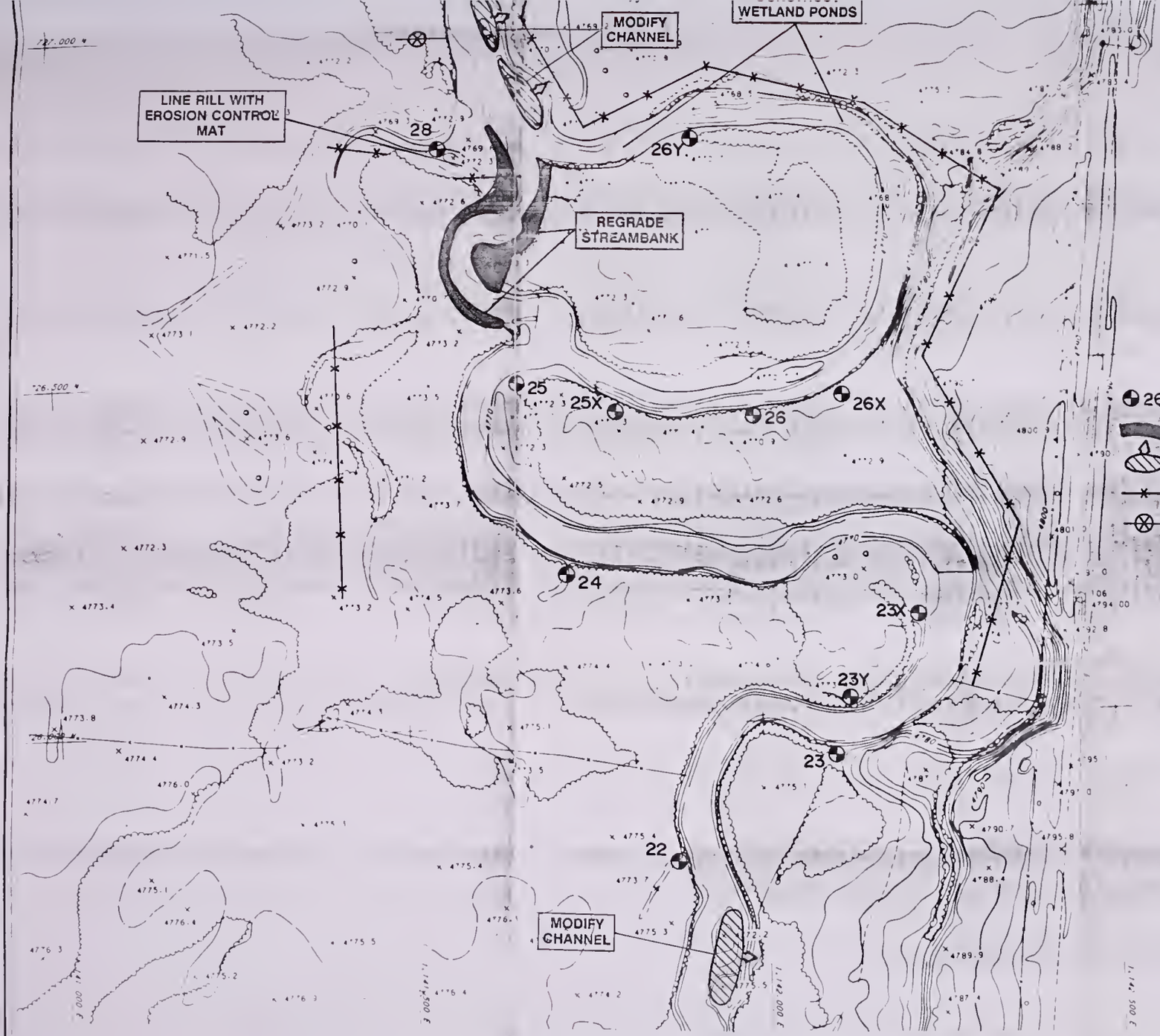
LEGEND

- DEEP PLOW
- AGRICULTURE TILLAGE
- AREAS REQUIRING CLEARING AND GRUBBING

SHEET 3 SUMMARY

Agricultural Tillage	Deep Plow One Lime Lift	Deep Plow Two Lime Lifts	Top Dressing (Estimated)	Subtotal
10.6 Acres	12.9 Acres	8.6 Acres	0.0 Acres	32.1 Acres
530 Tons	1,084 Tons	1048 Tons	0.0 Tons	2,662 Tons


REGRADE STREAMBANK
REGRADE STREAMBANK
REGRADE STREAMBANK
CONSTRUCT WETLAND PONDS
MODIFY CHANNEL
35L
33
33L
32L
30L
31X
30
728.000 N
727.500 N
727.000 N
1,142,000 E
1,143,000 E
LEGEND
GRAVEL ROAD
TRAIL
BRIDGE
CULVERT
LAKE/POND
DRAINAGE LINE
STREAM
TREE
TREE COVER
FENCE
GATE
WING WALL
POLE
GROUND CONTROL
INDEX CONTOUR
INTERMEDIATE CONTOUR
DEPRESSION CONTOUR
SEDIMENT CONTROL STRUCTURES



SEDIMENT CONTROL STRUCTURES			
LOCATION	SIZE	LOCATION	SIZE
22	M	28	L
23	M	30	M
23Y	S	30L	S
23X	M	31X	M
24	M	32L	S
25	S	33L	M
25Y	S	33	S
26	S	35	M
26X	S		

LEGEND

- 26 — SEDIMENT CONTROL STRUCTURE
- REGRADE STREAMBANK
- MODIFY CHANNEL
- NEW FENCE
- GATE

INTERMEDIATE CONTOUR

DEPRESSION CONTOUR

OBSCURED CONTOUR

x 1739.6 SPOT ELEVATION

Sheets rotated 2.31° From North

WARM SPRINGS AREA
Montana

Scale 1" = 100'

Contour Interval = 2'

Date of Photography 10-20-87

Compiled By:
HORIZONS, INC.
Rapid City,
South Dakota

Schafer and Associates
P O Box 8188
Bozeman MT 59715
(406) 587-3478

CLARK FORK DEMO PROJECT

TOPOGRAPHIC MAP

CLIENT:
LOCATION
SHEET 2 OF 4
DRAWING NUMBER
REVISION NUMBER
DATE
SCALE

MODIFY CHANNEL

REGRADE STREAMBANK

MODIFY CHANNEL

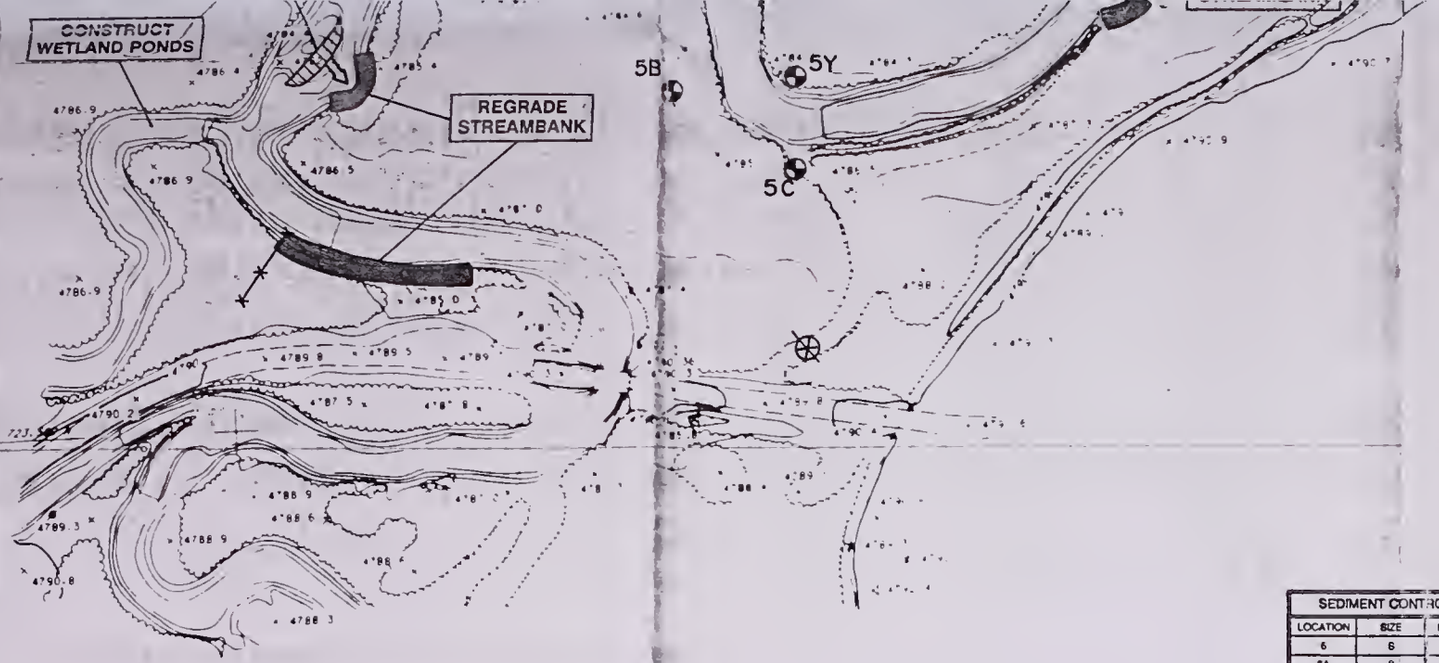
CONSTRUCT WETLAND PONDS

REGRADE STREAMBANK

REGRADE

LEGEND

GRAVEL ROAD
TRAIL
BRIDGE
CULVERT
LAKE/POND
DRAINAGE LINE
STREAM
TREE
TREE COVER
FENCE
GATE
WING WALL
POLE
GROUND CONTROL
INDEX CONTOUR
INTERMEDIATE CONTOUR
DEPRESSION CONTOUR



INTERMEDIATE CONTOUR

DEPRESSION CONTOUR

OBSCURED CONTOUR

x 1739.6 SPOT ELEVATION

Sheets rotated 2.31° from North

SEDIMENT CONTROL STRUCTURES			
LOCATION	SIZE	LOCATION	SIZE
5	S	10	M
5A	S	11	L
5B	L	12	M
5C	S	15	S
5Y	S	17	S
5X	S	18	M
6	S	19	M
7	M	19X	S
9L	S	20	M

LEGEND

- 5A SEDIMENT CONTROL STRUCTURE
- REGRADE STREAMBANK
- MODIFY CHANNEL
- NEW FENCE
- GATE

WARM SPRINGS AREA

Montana

Scale 1" = 100'

Contour Interval = 2'

Date of Photography 10-20-87

Compiled By:

HORIZONS, INC.

Rapid City,

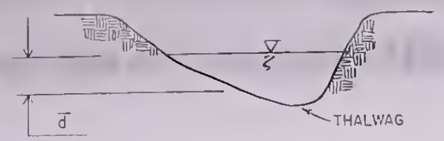
South Dakota

Schafer and Associates
P.O. Box 6186
Bozeman MT 59715
(406) 587-3478

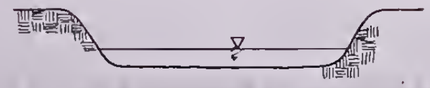
CLARK FORK DEMO PROJECT

TOPOGRAPHIC MAP

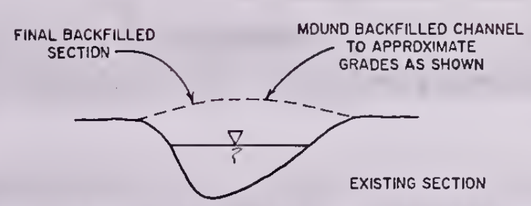
CLIENT	
LOCATION	
SHEET 1 OF 4	
DRAWING NUMBER:	
REVISION NUMBER:	
DATE:	
SCALE:	
DRAWN BY:	
CHECKED BY:	



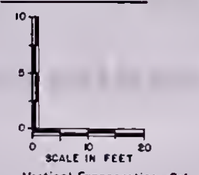
POOL (TYPICAL SECTION)
SECTION A-A



RIFFLE (TYPICAL SECTION)
SECTION B-B

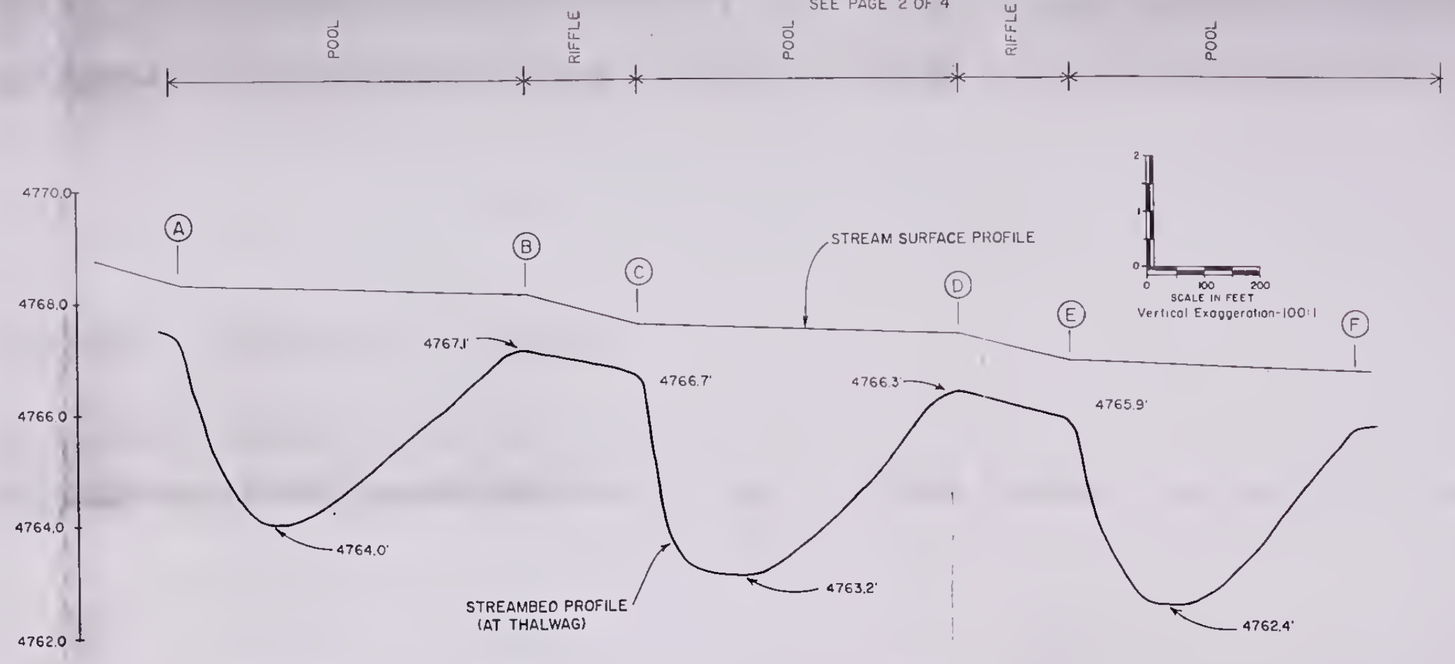


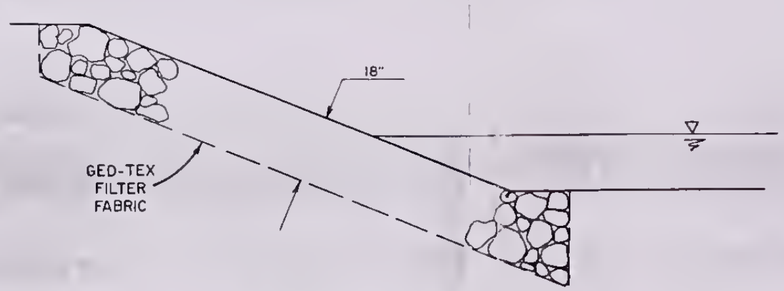
MEANDER CUTOFF (TYPICAL SECTION)
SECTION C-C



MEANDER RESTORATION DETAIL

SEE PAGE 2 OF 4





RIP-RAP DETAIL
(IF REQUIRED)

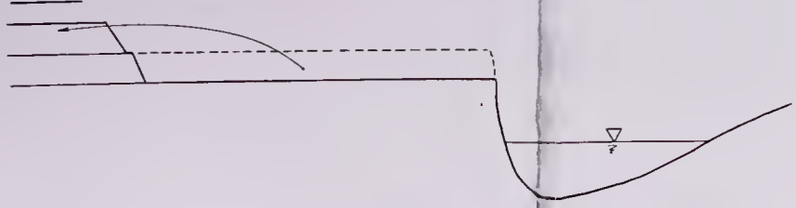
PROPOSED STREAMBANK REMEDIATION

EXISTING (TYPICAL)

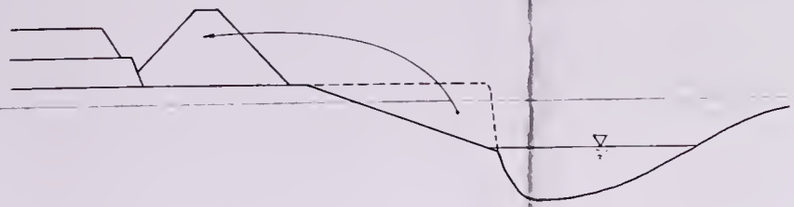
STEP 1 (REMOVE TAILINGS)

STEP 3 (COMPLETE GRADING FOLLOWING LIME APPLICATION)
INSTALL EROSION CONTROL

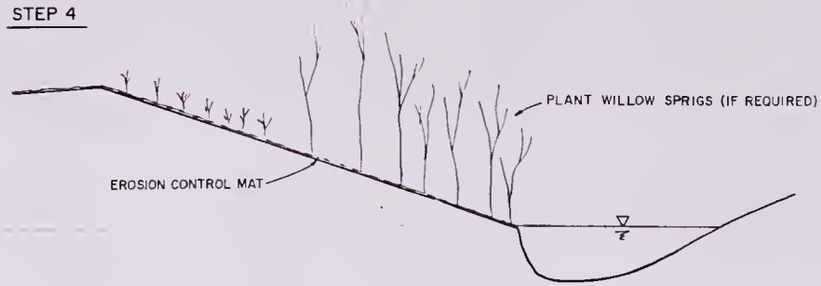
STEP 1 (REMOVE TAILINGS)



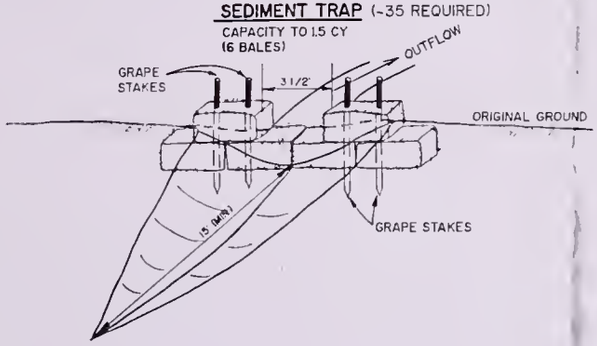
STEP 2 (GRADE STREAMBANK & CONSTRUCT TEMPORARY DIKE WITH CLEAN ALLUVIUM)
APPLY LIME



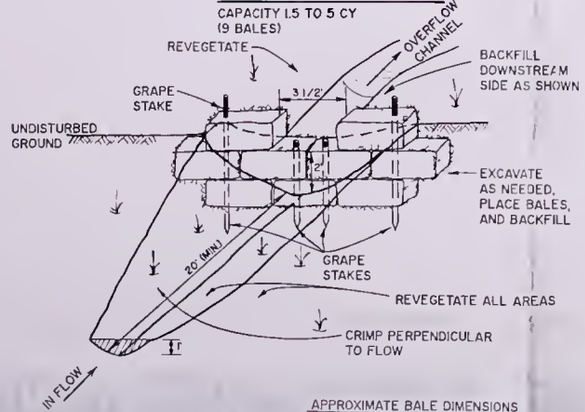
STEP 4



SEDIMENT TRAP (~35 REQUIRED)
CAPACITY TO 1.5 CY
(6 BALES)

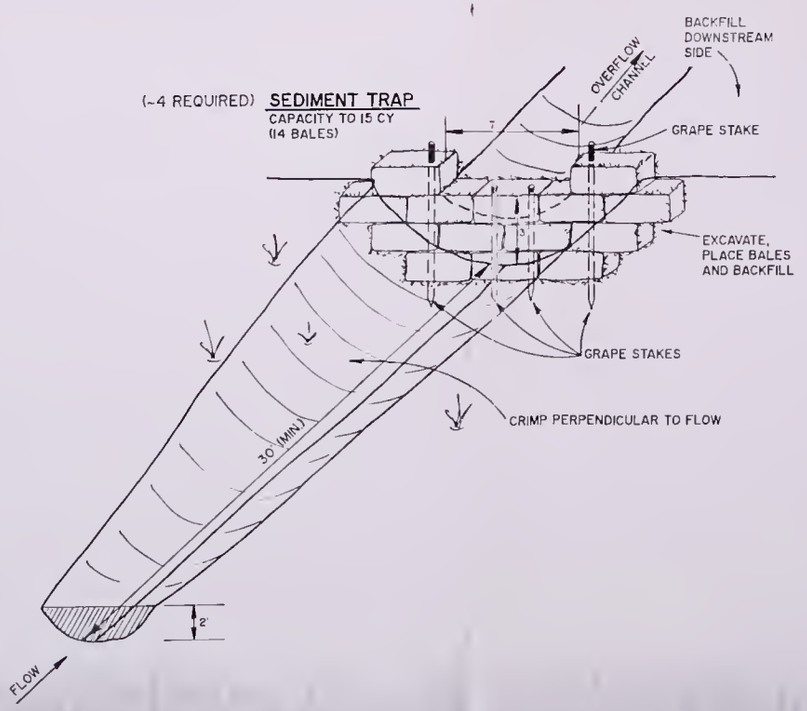


TYPICAL SEDIMENT TRAP (~18 REQUIRED)
CAPACITY 1.5 TO 5 CY
(9 BALES)



APPROXIMATE BALE DIMENSIONS
LENGTH ≈ 3 1/2 feet
WIDTH ≈ 1 1/2 feet
HEIGHT ≈ 1 1/4 feet

(~4 REQUIRED) **SEDIMENT TRAP**
CAPACITY TO 15 CY
(14 BALES)

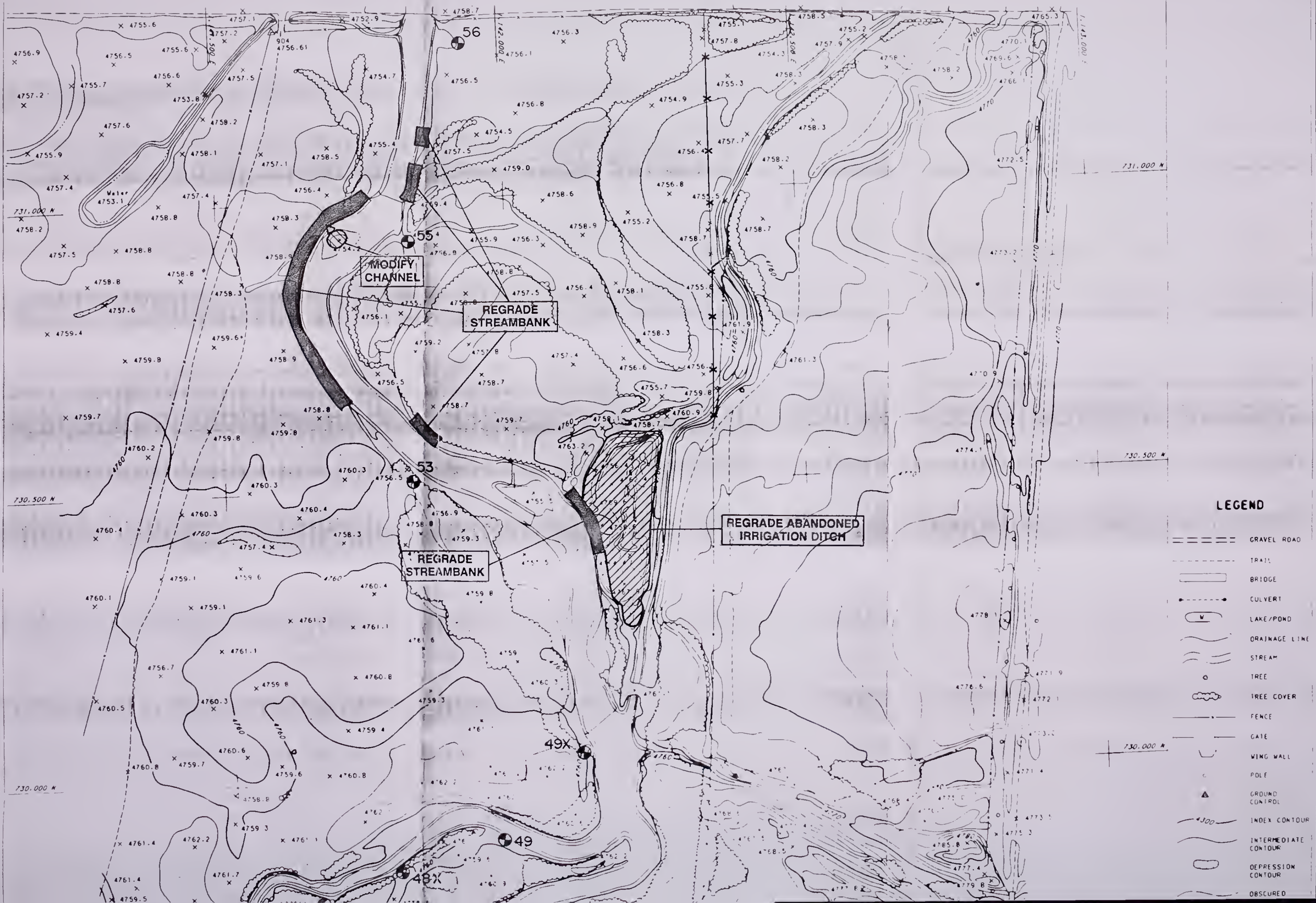


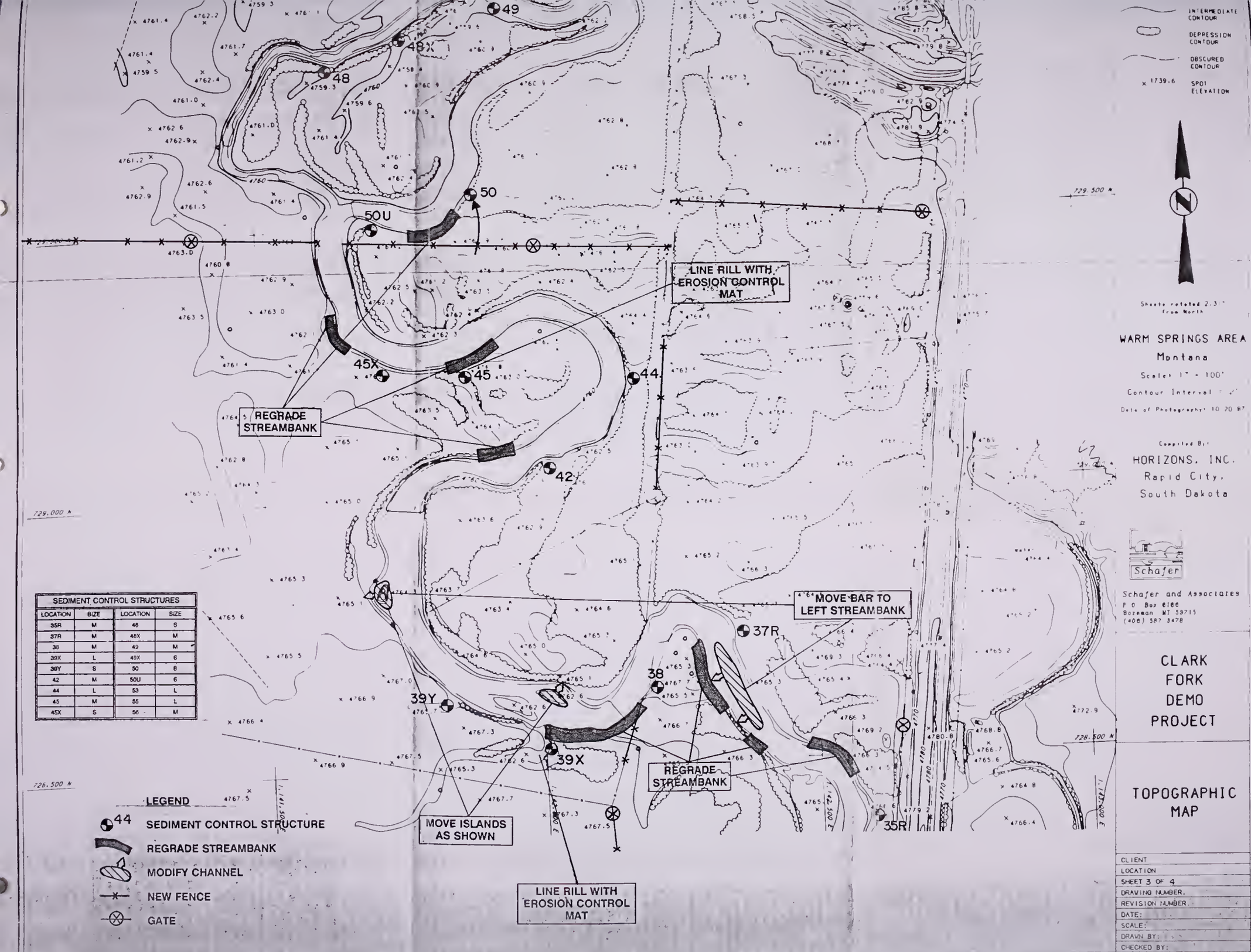
Schafer and Associates
P O Box 6166
Bozeman MT 59715
(406) 587-3478

CLARK FORK DEMO PROJECT

DETAIL SHEET

CLIENT:	
LOCATION:	
SHEET 4 OF 4	
DRAWING NUMBER:	
REVISION NUMBER:	
DATE:	
SCALE:	
DRAWN BY: LNR	
CHECKED BY:	


MODIFY CHANNEL
REGRADE STREAMBANK
REGRADE STREAMBANK
REGRADE ABANDONED IRRIGATION DITCH
56
55
53
49X
49
48X
731,000 N
730,500 N
730,000 N
LEGEND
GRAVEL ROAD
TRAIL
BRIDGE
CULVERT
LAKE/POND
DRAINAGE LINE
STREAM
TREE
TREE COVER
FENCE
GATE
WING WALL
POLE
GROUND CONTROL
INDEX CONTOUR
INTERMEDIATE CONTOUR
DEPRESSION CONTOUR
OBSCURED



SEDIMENT CONTROL STRUCTURES			
LOCATION	SIZE	LOCATION	SIZE
35R	M	48	S
37R	M	48X	M
38	M	49	M
39X	L	49X	6
39Y	S	50	8
42	M	50U	6
44	L	53	L
45	M	55	L
45X	S	56	M

LEGEND

- 44 SEDIMENT CONTROL STRUCTURE
- REGRADE STREAMBANK
- MODIFY CHANNEL
- NEW FENCE
- GATE


4765.3
4760
4770.1
4769.6
4768.1
4770
4772.5
4773.2
1,145,000 E
731,000 N

APPENDIX C.

LANDOWNER MANAGEMENT PLAN

Schafer & Associates
P.O. Box 6186
Bozeman, MT 59715
(406) 587-3478

Waste Management
Land Reclamation
Resource Inventory
Agricultural Consulting

January 7, 1990

Duane Logan
12605 Eastside Rd
Anaconda, MT 59711

Dear Mr. Logan,

This letter is in reference to the Grazing Management Plan, as stated in the Licence Agreement for Reclamation Work Contract, signed June 15th of 1990. The Licensee, in consultation with its agents, employees, consultants, along with the Soil Conservation Service has developed a three year Grazing Management Plan.

1991 - no grazing on recently reseeded areas. This time is needed to allow grass species to establish and develop before grazing.

1992 - light grazing late July or early August. Approximately two - three weeks use or until four (4) inches stubble height, then move cattle out.

1993 - early spring grazing for a short time. The streambanks are soft and can be easily disturbed. Watch stubble height and streambanks to determine length of grazing. Area will be grazed again in the fall until stubble height is four (4) inches.

At no time shall the Owner allow the stubble height to be shorter than four (4) inches. The Owner must contact Licensee prior to allowing cattle to enter the area. Owners are under obligation to maintain fences and the integrity of the Grazing Management Plan.

The objective of the Grazing Management Plan is to improve the entire riparian unit, to maintain increased forage production for livestock, improve wildlife and fisheries habitats and decrease soil erosion. It is strongly recommended that the "swap area", between Mr. Logan and FWP/Arco, adhere to the guidelines of removing cattle once a four (4) inch stubble height is achieved. This stubble height will insure adequate vigor and carbohydrate reserves for continued plant growth. The FWP/Arco, in conjunction with the Soil Conservation Service and Mr. Logan, shall monitor and determine the stubble height to secure adequate plant growth for continued livestock grazing in the future.

Owner _____

Licensee _____

Please feel free to call if you have questions or comments regarding the Grazing Management Plan.

Schafer & Associates
P.O. Box 6186
Bozeman, MT 59715
(406) 587-3478

Waste Management
Land Reclamation
Resource Inventory
Agricultural Consulting

January 9, 1990

Hans J. Lampert
12204 Eastside Rd
Anaconda, MT 59711

Dear Mr. Lampert,

This letter is in reference to the Grazing Management Plan, as stated in the Licence Agreement for Reclamation Work Contract, signed June 15th of 1990. The Licensee, in consultation with its agents, employees, consultants, along with the Soil Conservation Service has developed a three year Grazing Management Plan.

1991 - no grazing on recently reseeded areas. This time is needed to allow grass species to establish and develop before grazing.

1992 - light grazing late July or early August. Approximately two - three weeks use or until four (4) inches stubble height, then move cattle out.

1993 - early spring grazing for a short time. The streambanks are soft and can be easily disturbed. Watch stubble height and streambanks to determine length of grazing. Area will be grazed again in the fall until stubble height is four (4) inches.

At no time shall the Owner allow the stubble height to be shorter than four (4) inches. The Owner must contact Licensee prior to allowing cattle to enter the area. Owners are under obligation to maintain fences and the integrity of the Grazing Management Plan.

Owner _____

Licensee _____